ROYAL SOCIETY OF NEW SOUTH WALES.

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JOURNAL

AND

PROCEEDINGS

OF THE

ROYAL SOCIETY

OF

NEW SOUTH WALES,

1878.

VOL. XII.

EDITED BY

PROF. LIVERSIDGE AND DR. LEIBIUS.

THE AUTHORS OF PAPERS ARE ALONE RESPONSIBLE FOR THE STATEMENTS MADE AND THE OPINIONS EXPRESSED THEREIN.

AGENTS FOR THE SOCIETY:

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1879.

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THE ROYAL SOCIETY OF NEW SOUTH WALES.

THE ROYAL SOCIETY of New South Wales originated in 1821 as the "Philosophical Society of Australia"; after an interval of inactivity, it was resuscitated in 1850, under the name of the "Australian Philosophical Society," by which title it was known until 1856, when the name was changed to the "Philosophical Society of New South Wales"; and finally, in May, 1866, by the sanction of Her Most Gracious Majesty the Queen, it assumed its present title.

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VOLUME XII.

PAPERS READ BEFORE THE SECTIONS.

The Royal Society of New South Wales.

OFFICERS FOR 1878–9.

PRESIDENT:

HIS EXCELLENCY SIR HERCULES ROBINSON, G.C.M.G., &c., &c., &c.

VICE-PRESIDENTS:

REV. W. B. CLARKE, M.A., F.R.S., F.G.S. (*Obiit, June* 16*th*, 1878.)
HON. J. SMITH, C.M.G., M.L.C., M.D., LL.D., &c.
CHARLES MOORE, F.L.S. (*Elected, July* 31*st*, 1878.)

HONORARY TREASURER:

H. C. RUSSELL, B.A., F.R.A.S., F.M.S., &c.

HONORARY SECRETARIES:

PROFESSOR LIVERSIDGE. | DR. ADOLPH LEIBIUS.

COUNCIL:

FITZGERALD, R. D., F.L.S.
GURNEY, PROFESSOR, M.A.
JONES, P. SYDNEY, M.D.
MONTEFIORE, E. L. (*Elected, July* 31, 1878.)
ROLLESTON, CHRISTOPHER.
WRIGHT, H. G. A., M.R.C.S. ENG.

ASSISTANT SECRETARY:

W. H. WEBB.

FUNDAMENTAL RULES.

Object of the Society.

1. The object of the Society is to receive at its stated meetings original papers on subjects of Science, Art, Literature, and Philosophy, and especially on such subjects as tend to develop the resources of Australia, and to illustrate its Natural History and Productions.

President.

2. The Governor of New South Wales shall be *ex officio* the President of the Society.

Other Officers.

3. The other Officers of the Society shall consist of two Vice-Presidents, a Treasurer, and two or more Secretaries, who, with six other Members, shall constitute a Council for the management of the affairs of the Society.

Election of Officers.

4. The Vice-Presidents, Treasurer, Secretaries, and the six other Members of Council, shall be elected annually at the General Meeting in the month of May.

Vacancies during the year.

5. Any vacancies occurring in the Council of Management during the year may be filled up by the Council.

Fees.

6. The entrance money paid by Members on their admission shall be One Guinea; and the annual subscription shall be One Guinea, payable in advance.

The sum of Ten Pounds may be paid at any time as a composition for the ordinary annual payment for life.

Honorary Members.

7. The Honorary Members of the Society shall be persons who have been eminent benefactors to this or some other of the Australian Colonies, or distinguished patrons and promoters of the objects of the Society. Every person proposed as an Honorary Member must be recommended by the Council and elected by the Society. Honorary Members shall be exempted from payment of fees and contributions; they may attend the meetings of the Society, and they shall be furnished with copies of Transactions and Proceedings published by the Society, but they shall have no right to hold office, to vote, or otherwise interfere in the business of the Society.

Confirmation of By-laws.

8. By-laws proposed by the Council of Management shall not be binding until ratified by a General Meeting.

Alteration of Fundamental Rules.

9. No alteration of or addition to the Fundamental Rules of the Society shall be made unless carried at two successive general meetings.

BY-LAWS

Passed at a General Meeting of the Society, held June 7th, 1876.

Ordinary General Meetings.

I. An Ordinary General Meeting of the Royal Society, to be convened by public advertisement, shall take place at 8 p.m., on the first Wednesday in every month, during the last eight months of the year; subject to alteration by the Council with due notice. These meetings will be open for the reading of papers, and the discussion of subjects of every kind if brought forward in conformity with the Fundamental Rules and By-laws of the Society.

Annual General Meeting.—Annual Reports.—Election of Officers.

II. A General Meeting of the Society shall be held annually in May, to receive a Report from the Council on the state of the Society, and to elect Officers for the ensuing year. The Treasurer shall also at this meeting present the annual financial statement.

Election of the Officers and Council.

III. The Officers and other members of the Council shall be elected annually *by ballot* at the Annual General Meeting to be held in May.

IV. It shall be the duty of the Council each year to prepare a list containing the names of members whom they recommend for election to the respective offices of Vice-Presidents and Hon. Secretaries and Hon. Treasurer, together with the names of six other members whom they recommend for election as ordinary members of Council. The names thus recommended shall be proposed at one meeting of the Council, and agreed to at a subsequent meeting.

V. Each member present at the General Annual Meeting shall have the power to alter the list of names recommended by the Council, by adding to it the names of any eligible members not already included in it and removing from it an equivalent number of names, and he shall use this list with or without such alterations as a balloting list at the election of Officers and Council.

Council Meetings.

VI. Meetings of the Council of Management shall take place on the last Wednesday in every month, and on such other days as the Council may determine.

Absence from Meetings of Council.—Quorum.

VII. Any member of the Council absenting himself from three consecutive meetings of the Council, without giving a satisfactory explanation in writing, shall be considered to have vacated his office, and the election of a member to fill his place shall be proceeded with at the next Council meeting in accordance with Fundamental Rule 5. No business shall be transacted at any meeting of the Council unless three members are present.

Duties of Secretaries.

VIII. The Honorary Secretaries shall perform, or shall cause the Assistant Secretary to perform, the following duties :—

1. Conduct the correspondence of the Society and Council.

2. Attend the General Meetings of the Society and the meetings of the Council, to take minutes of the proceedings of such meetings, and at the commencement of such to read aloud the minutes of the preceding meeting.

3. At the Ordinary Meetings of the members, to announce the presents made to the Society since their last meeting; to read the certificates of candidates for admission to the Society, and such original papers communicated to the Society as are not read by their respective authors, and the letters addressed to it.

4. To make abstracts of the papers read at the Ordinary General Meetings, to be inserted in the Minutes and printed in the Proceedings.

5. To edit the Transactions of the Society, and to superintend the making of an Index for the same.

6. To be responsible for the arrangement and safe custody of the books, maps, plans, specimens, and other property of the Society.

7. To make an entry of all books, maps, plans, pamphlets, &c., in the Library Catalogue, and of all presentations to the Society in the Donation Book.

8. To keep an account of the issue and return of books, &c., borrowed by members of the Society, and to see that the borrower, in every case, signs for the same in the Library Book.

9. To address to every person elected into the Society a printed copy of the Forms Nos. 2 and 3 (in the Appendix), together with a list of the members, a copy of the Fundamental Rules and By-laws, and a card of the dates of meeting; and to acknowledge all donations made to the Society, by Form No. 5.

10. To cause due notice to be given of all Meetings of the Society and Council.

11. To be in attendance at 4 p.m. on the afternoon of Wednesday in each week during the session.

12. To keep a list of the attendances of the members of the Council at the Council Meetings and at the Ordinary General Meetings of the members of the Society, in order that the same may be laid before the Society at the Annual General Meeting held in the month of May.

The Honorary Secretaries shall, by mutual agreement, divide the performance of the duties above enumerated.

The Honorary Secretaries shall, by virtue of their office, be members of all Committees appointed by the Council.

Candidates for admission.

IX. Every candidate for admission as an ordinary member of the Society shall be recommended according to a prescribed form, by not less than three members, to two of whom he must be personally known.

Election of new Members.

X. The names of such candidates, with the names of their supporters, shall be read by one of the Secretaries at an Ordinary General Meeting of the Society. The vote as to admission to take place by ballot at the next subsequent meeting. At the ballot the assent of at least four-fifths of the members voting shall be requisite for the admission of the candidate.

New Members to be informed of their election.

XI. Every new member shall receive due notification of his election, and be supplied with a copy of the obligation (No. 3 in Appendix), together with a copy of the Fundamental Rules and By-laws of the Society, a list of members, and a card of the dates of meeting.

Members whose subscriptions are unpaid to enjoy no privileges.

XII. An elected member shall not be entitled to attend the meetings or to enjoy any privilege of the Society, nor shall his name be printed in the list of the Society, until he shall have paid his admission fee and first annual subscription, and have returned to the Secretaries the obligation signed by himself.

Members shall sign Rules—Formal admission.

XIII. Every member who has complied with the preceding By-laws shall at the first Ordinary General Meeting at which he shall be present, sign a duplicate of the aforesaid obligation in a book to be kept for that purpose, after which he shall be presented by some member to the Chairman, who, addressing him by name, shall say :—" By the authority and in the name of the Royal Society of New South Wales I admit you a member thereof."

Annual subscriptions, when due.

XIV. Annual subscriptions shall become due on the 1st of May for the year then commencing. The entrance fee and first year's subscription of a new member shall become due on the day of his election.

Subscriptions in arrear.

XV. Members who have not paid their subscriptions for the current year, on or before the 31st of May, shall be informed of the fact by the Hon. Treasurer, and any member who shall be two years in arrear with his subscriptions shall be considered to have resigned.

At the meeting held in July, and at all subsequent meetings for the year, a list of the names of all those members who are in arrear with their annual subscriptions shall be suspended in the Rooms of the Society. Members shall in such cases be informed that their names have been thus posted.

Resignation of Members.

XVI. No member shall be at liberty to withdraw from the Society without previously giving notice to one of the Secretaries of his desire to withdraw, and returning all books or other property belonging to the Society. Members will be considered liable for the payment of all subscriptions due from them up to the date at which they may give notice of their intention to withdraw from the Society.

Expulsion of Members.

XVII. A majority of members present at any ordinary meeting shall have power to expel an obnoxious member from the Society, provided that a resolution to that effect has been moved and seconded at the previous ordinary meeting, and that due notice of the same has been sent in writing to the member in question, within a week after the meeting at which such resolution has been brought forward.

Contributions to the Society.

XVIII. Contributions to the Society, of whatever character, must be sent to one of the Secretaries, to be laid before the

Council of Management. It will be the duty of the Council to arrange for promulgation and discussion at an Ordinary Meeting such communications as are suitable for that purpose, as well as to dispose of the whole in the manner best adapted to promote the objects of the Society.

Order of Business.

XIX. At the Ordinary General Meetings the business shall be transacted in the following order, unless the Chairman specially decide otherwise:—

1—Minutes of the preceding Meeting.
2—New Members to enrol their names and be introduced.
3—Ballot for the election of new Members.
4—Candidates for membership to be proposed.
5—Business arising out of Minutes.
6—Communications from the Council.
7—Communications from the Sections.
8—Donations to be laid on the Table and acknowledged.
9—Correspondence to be read.
10—Motions from last Meeting.
11—Notices of Motion for the next Meeting to be given in.
12—Papers to be read.
13—Discussion.
14—Notice of Papers for the next Meeting.

Admission of Visitors.

XX. Every ordinary member shall have the privilege of admitting two friends as visitors to an Ordinary General Meeting of the Society, on the following conditions :—

1. That the name and residence of the visitors, together with the name of the member introducing them, be entered in a book at the time.
2. That they shall not have attended two consecutive meetings of the Society in the current year.

The Council shall have power to introduce visitors, irrespective of the above restrictions.

Management of Funds.

XXI. The funds of the Society shall be lodged at a Bank named by the Council of Management. Claims against the Society, when approved by the Council, shall be paid by the Treasurer.

Money Grants.

XXII. Grants of money in aid of scientific purposes from the funds of the Society—to Sections or to members—shall expire on the 1st of November in each year. Such grants, if not expended, may be re-voted.

XXIII. Such grants of money to Committees and individual members shall not be used to defray any personal expenses which a member may incur.

Audit of Accounts.

XXIV. Two Auditors shall be appointed annually, at an Ordinary Meeting, to audit the Treasurer's Accounts. The accounts as audited to be laid before the Annual Meeting in May.

Property of the Society to be vested in the Vice-Presidents, &c.

XXV. All property whatever belonging to the Society shall be vested in the Vice-Presidents, Hon. Treasurer, and Hon. Secretaries for the time being, in trust for the use of the Society; but the Council shall have control over the disbursements of the funds and the management of the property of the Society.

Library.

XXVI. The Members of the Society shall have access to, and shall be entitled to borrow books from the Library, under such regulations as the Council may think necessary.

Museum.

XXVII. It shall be one of the objects of the Society to form a Museum.

Branch Societies.

XXVIII. The Society shall have power to form Branch Societies in other parts of the Colony.

Sections.

XXIX. To allow those members of the Society who devote attention to particular branches of science fuller opportunities and facilities of meeting and working together with fewer formal restrictions than are necessary at the general Monthly Meetings of the Society,—Sections or Committees may be established in the following branches of science:—

Section A.—Astronomy, Meteorology, Physics, Mathematics, and Mechanics.

Section B.—Chemistry and Mineralogy, and their application to the Arts and Agriculture.

Section C.—Geology and Palæontology.

Section D.—Biology, *i.e.*, Botany and Zoology, including Entomology.

Section E.—Microscopical Science.

Section F.—Geography and Ethnology.

Section G.—Literature and the Fine Arts, including Architecture.

Section H.—Medical.

Section I.—Sanitary and Social Science and Statistics.

Reports from Sections.

XXX. There shall be for each Section a Chairman to preside at the meetings, and a Secretary to keep minutes of the proceedings, who shall jointly prepare and forward to the Hon. Secretaries of the Society, on or before the 7th of November in each year, a report of the proceedings of the Section during that year, in order that the same may be transmitted to the Council.

Section Committees—Card of Meetings.

XXXI. The first meeting of each Section shall be appointed by the Council. At that meeting the members shall elect their own Chairman, Secretary, and a Committee of four; and arrange the days and hours of their future meetings. A card showing the dates of each meeting for the current year shall be printed for distribution amongst the members of the Society.

Money Grants to Sections.

XXXII. By application to the Council, grants of money may be made out of the General Funds of the Society to the Sections.

Membership of Sections.

XXXIII. No person who is not a member of the Society shall have the privilege of joining any of the Sections.

THE LIBRARY.

1. During the Session, the Library shall be open for consultation and for the issue and return of books between 4 and 6 p.m. on the afternoon of each Wednesday, and between 7 and 10 p.m. on the evenings of Monday, Wednesday, and Friday, and during the recess (January to end of April) on Wednesdays, from 4 to 6 and 7 to 10 p.m.

2. No book shall be issued without being signed for in the Library Book.

3. Members are not allowed to have more than two volumes at a time from the Library, without special permission from one of the Honorary Secretaries, nor to retain a book for a longer period than fourteen days; but when a book is returned by a member it may be borrowed by him again, provided it has not been bespoken by any other member. Books which have been bespoken shall circulate in rotation, according to priority of application.

4. Scientific Periodicals and Journals are not to be borrowed until the volumes are completed and bound.

5. Members retaining books longer than the time specified shall be subject to a fine of sixpence per week for each volume.

6. The books which have been issued shall be called in by the Secretaries twice a year; and in the event of any book not being returned on those occasions, the member to whom it was issued shall be answerable for it, and shall be required to defray the cost of replacing the same.

Form No. 1.

ROYAL SOCIETY OF NEW SOUTH WALES.

Certificate of a Candidate for Election.

Name

Qualification or occupation

Address

being desirous of admission into the Royal Society of New South Wales, we, the undersigned members of the Society, propose and recommend him as a proper person to become a member thereof.

Dated this day of , 18 .

FROM PERSONAL KNOWLEDGE.	FROM GENERAL KNOWLEDGE.

Signature of candidate

Date received 18 .

Form No. 2.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,

Sir, Sydney, 18 .

I have the honor to inform you that you have this day been elected a member of the Royal Society of New South Wales, and I beg to forward to you a copy of the Fundamental Rules and By-laws of the Society, a printed copy of an obligation, a list of members, and a card announcing the dates of meeting during the present session.

According to the Regulations of the Society (*vide* Rule No. 6), you are required to pay your admission fee of one guinea, and annual subscription of one guinea for the current year, before admission. You are also requested to sign and return the enclosed form of obligation at your earliest convenience.

I have the honor to be,

Sir,

Your most obedient servant,

To Hon. Secretary.

Form No. 3.

ROYAL SOCIETY OF NEW SOUTH WALES.

I, the undersigned, do hereby engage that I will endeavour to promote the interests and welfare of the Royal Society of New South Wales, and to observe its Rules and By-laws, as long as I shall remain a member thereof.

Signed,

Address

Date

Form No. 4.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,

Sir, Sydney, 18 .

I have the honor to inform you that your annual subscription of one guinea for the current year became due to the Royal Society on the 1st of May last.

It is requested that payment may be made by cheque or Post Office order drawn in favour of the Hon. Treasurer.

I have the honor to be,

Sir,

Your most obedient servant,

To Hon. Treasurer.

Form No. 5.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,

Sir, Sydney, 18 .

I am desired by the Royal Society of New South Wales to forward to you a copy of its Journal for the year 18 , as a donation to the library of your Society.

I am further requested to mention that the Society will be thankful to receive such of the very valuable publications issued by your Society as it may feel disposed to send.

I have the honor to be,

Sir,

Your most obedient servant,

Hon. Secretary.

Form No. 6.

ROYAL SOCIETY OF NEW SOUTH WALES.

The Society's Rooms,

Sir, Sydney, 18 .

On behalf of the Royal Society of New South Wales, I beg to acknowledge the receipt of and I am directed to convey to you the best thanks of the Society for your most valuable donation.

I have the honor to be,

Sir,

Your most obedient servant,

Hon. Secretary.

Form No. 7.

Balloting List for the Election of the Officers and Council.

ROYAL SOCIETY OF NEW SOUTH WALES.

May, 18 .

BALLOTING LIST for the election of the Officers and Council.

Present Council.	Names proposed as Members of the new Council.	
	Vice-Presidents.	
	Hon. Treasurer.	
	Hon. Secretaries.	
	Members of Council.	

If you wish to substitute any other name in place of that proposed, erase the printed name in the second column, and write opposite to it, in the third, that which you wish to substitute.

LIST OF THE MEMBERS

OF THE

Royal Society of New South Wales.

P Members who have contributed papers which have been published in the Society's Transactions or Journal. The numerals indicate the number of such contributions.
† Members of the Council.
‡ Life Members.

Elected.		
1877		Abbott, Joseph Palmer, Murrurundi.
1877		Abbott, Thomas Kingsmill, P.M., Gunnedah.
1877		Abbott, W. E., Glengarry, Wingen.
1877		Adams, Francis, A.J.S. Bank, Sydney.
1864		Adams, P. F., Surveyor General, Kirribilli Point, St. Leonards.
1878		Alexander, George M., 48, Margaret-street.
1874		Alger, John, Macquarie-street.
1870		Allen, The Hon. Sir George Wigram, M.P., Speaker of the Legislative Assembly, Elizabeth-street North.
1868		Allerding, F., Hunter-street.
1873		Allerding, H. R., Hunter-street.
1856		Allwood, Rev. Canon, B.A. *Cantab.*, Vice-Chancellor, University of Sydney, Woollahra.
1876		Alston, John Wilson, M.B. *Edin.*, Mast. Surg. *Edin.*, 455, Pitt-street.
1877		Anderson, A. W., Oriental Bank, Sydney.
1877		Anderson, H. C. L., M.A., Sydney Grammar School.
1876		Armstrong, W. D., Surveyor General's Office.
1878		Archer, W. H., F.I.A., Australian Club.
1876		Atchison, Cunningham Archibald, C.E., North Shore.
1873		Atherton, Ebenezer, M.R.C.S. *Eng.*, O'Connell-street.
1873		Austen, Henry, Hunter-street.
1876		Backhouse, Benjamin, Ithaca, Elizabeth Bay.
1878		Backhouse, Alfred P., M.A., Ithaca, Elizabeth Bay.
1878		Balfour, James, Union Club.
1876	P 4	Barkas, Wm. James, Lic. R. Col. Phys. *Lond.*, M.R.C.S. *Eng.*, Warialda.
1878		Barker, Francis Lindsay, 130, Pitt-street.

Elected.	
1875	Bartels, W. C. W., Union Club.
1876	Bassett, W. F., M.R.C.S., *Eng.*, Bathurst.
1878	Bayley, George W. A., Railway Department, Phillip-street.
1875	Bedford, W. J. G., M.R.C.S. *Eng.*, Staff Surgeon.
1868	Beilby, E. T., Pitt-street.
1875	Belgrave, Thomas B., M.D. *Edin.*, M.R.C.S. *Eng.*, 153 Eliza-

NOTICE.

Members are particularly requested to communicate any change of address to the Hon. Secretaries, for which purpose this slip is inserted.

Corrected Address.

Name ....

Titles, &c. ....

Address ....

....

Date ....

To the

Hon. Secretaries,

Royal Society of N. S. W.,

Elizabeth-st., Sydney.

1876	Campbell, The Hon. John, M.L.C., Clunes, South Kingston.
1870	Cane, Alfred, Stanley-street.

LIST OF THE MEMBERS

1878	Barker, Francis Lindsay, 130, Pitt-street.

Elected.		
1875		Bartels, W. C. W., Union Club.
1876		Bassett, W. F., M.R.C.S., *Eng.*, Bathurst.
1878		Bayley, George W. A., Railway Department, Phillip-street.
1875		Bedford, W. J. G., M.R.C.S. *Eng.*, Staff Surgeon.
1868		Beilby, E. T., Pitt-street.
1875		Belgrave, Thomas B., M.D. *Edin.*, M.R.C.S. *Eng.*, 158 Elizabeth-street.
1877		Belfield, Algernon H., Eversleigh, Armidale.
1875		Belisario, John, M.D., Lyons' Terrace.
1876		Benbow, Clement A., 24, College-street.
1869	P 2	Bensusan, S. L., Exchange, Pitt-street.
1877		Bennett, George F., C.M.Z.S., Toowoomba, Queensland.
1878		Berney, Augustus, H. M. Customs, Sydney.
1878		Bestic, Edwin Henry, L.R.C.S., *Irel.*, L.R.C.P., *Edin.*, Arthursleigh-terrace.
1878		Black, Reginald James, Bank of New South Wales, Sydney.
1878		Black, Morrice A., F.I.A., Actuary, Mutual Provident Society.
1877		Bladen, Thomas, Pyrmont.
1869		Bode, Rev. G. C., St. Leonards, North Shore.
1872		Bolding, H. J., P.M., Newcastle and Union Club.
1874		Bowen, George M. C., Keston, Kirribilli Point, North Shore.
1858		Bradridge, Thomas H., Town Hall, George-street.
1876		Brady, Andrew John, Lic. K. & Q. Coll. Phys. *Irel.*, Lic. R. Coll. Sur. *Irel.*, Lyons' Terrace.
1871	P 1	Brazier, John, C.M.Z.S., Corr. M.R.S., Tas., 11, Windmill-street.
1868		Brereton, John Le Gay, M.D. *St. Andrew's*, L.R.C.S. *Edin.*, Domain Terrace.
1874		Brewster, John, George-street.
1876		Bristowe, E. H. C., 435, Crown-street, Sydney.
1876		Brodribb, W. A., F.R.G.S., Double Bay.
1878		Brooks, Joseph, F.R.G.S., Hope Bank, Nelson-st., Woollahra.
1876		Brown, Henry Joseph, Newcastle.
1876		Brown, Thomas, Eskbank, Bowenfels, and Australian Club.
1878		Brown, Thomas, J.P., Darlinghurst Road.
1877		Bundock, W. C., Australian Club.
1876		Burn, James Henry, 93, Palmer-street, Woolloomooloo.
1875		Burton, Edmund, Land Titles Office, Elizabeth-street North.
1877		Burnell, Arthur, Survey Office.
1878		Burnett, Robt. H., C.E., Railway Department.
1875		Busby, The Hon. William, M.L.C., Redleaf, South Head Road, Woollahra.
1878		Butterfield, George, Survey Office.
1876		Cadell, Alfred, Vegetable Creek, New England.
1876		Cadell, Thomas, Wotonga, East St. Leonards.
1876		Campbell, Allan, L.R.C.P., *Glasgow*, Yass.
1876		Campbell, The Hon. Alexander, M.L.C., Woollahra.
1868		Campbell, The Hon. Charles, M.L.C., Clunes, South Kingston.
1872		Campbell, The Hon. John, M.L.C., Clunes, South Kingston.
1870		Cane, Alfred, Stanley-street.

Elected.		
1876		Cape, Alfred J., Torfrida, Elizabeth Bay.
1876		Chandler, Alfred, 185, Pitt-street.
1878		Chatfield, William, 69, Pitt-street.
1878		Chisholm, Edwin, M.D., M.R.C.S., L.S.A., &c., Ashfield.
1876		Christie, Wm., L.S., Hawthorn Lodge, Glen Innes.
1850	P 18	†Clarke, Rev. W. B., M.A. *Cantab.*, F.R.S., F.G.S., C.M.Z.S., F.R.G.S., Mem. Geol. Soc. France, Corres. Imp. Roy. Geol. Inst. Austria, Hon. Mem. N.Z. Inst. Cor. Mem. Roy. Soc. Tasmania, Fellow of St. Paul's College, *Vice-President*, Branthwaite, St. Leonards, North Shore. *Obiit, June* 16, 1878.
1877		Clarke, William, E. S. & A. C. Bank, Pitt-street.
1874		Clay, William French, M.A., *Cantab.*, M.D. *Syd.*, M.R.C.S. *Eng.*, Fellow of St. Paul's Col., North Shore.
1876		Clune, Michael Joseph, M.A.,Lic. K. & Q. Coll. Phys. *Irel.*, Lic. R. Coll. Sur. *Irel.*, 4, Hyde Park Terrace.
1876		Codrington, John Fredk., M.R.C.S., E.; Lic. R.C. Phys., L.; Lic. R.C. Phys., *Edin.*, Orange.
1878		Collie, Revd. Robert, Newtown.
1878		Colquhoun, George, 3, Mona-terrace, Rushcutters' Bay.
1876		Colyer, John Ussher Cox. A.S.N. Company, Sydney.
1856		Comrie, James, Northfield, Kurrajong Heights.
1876		Conder, Wm., Survey Office, Sydney.
1874		Combes, Edward, M.L.A., Bathurst.
1878		Cottee, Wm. Alfred, Spring-street.
1859	P 1	Cox, James, M.D. *Edin.* C.M.Z.S., F.L.S., Hunter-street.
1865	P 2	Cracknell, E. C., Superintendent of Telegraphs, Telegraph Office, George-street.
1869		Creed, J. Mildred, M.R.C.S. *Eng.*, Scone.
1870		Croudace, Thomas, Lambton.
1877		Cunningham, Andrew, Lanyon, Queanbeyan.
1873		Daintrey, Edwin, Æolia, Randwick.
1876		Dalgarno, John V., Telegraph Office, George-street.
1876		Dansey, George Frederick, M.R.C.S. *London*, York and Margaret Streets, Wynyard Square.
1875		Dangar, Frederick H., Greenknowes, Darlinghurst.
1876		Darley, Cecil West, Newcastle.
1877		Darley, F. M., M.A., Union Club, Sydney.
1876		Davidson, L. Gordon, M.D., M.C., *Aberdeen*, Goulburn.
1878		Dean, Alexander, Elizabeth-street.
1877		Deck, John Feild, M.D., 251, Macquarie-street.
1856		Deffell, George H., Bayfield, Woolwich Road, Hunter's Hill.
1869		De Lissa, Alfred, Pitt-street.
1878		De Lissa, S., 3, Barrack-street.
1875		De Salis, The Hon. Leopold Fane, M.L.C., Cuppercumbalong, Lanyon.
1875		De Salis, L. W., junr., Strathmore, Bowen, Queensland.

Elected.		
1873		Dibbs, George R., M.P., 131, Pitt-street.
1876		Dight, Arthur, Richmond.
1876		Dixon Douglas, Australian Club.
1875	P 5	Dixon, W. A., F.C.S., Fellow and Member Inst. of Chemistry of Gt. Britain and Irel., Lecturer on Chemistry, School of Arts; Chemical Laboratory, School of Arts, Sydney.
1876		Docker, Ernest, M.A. *Sydn.*, 134, Burton-street.
1876		Douglas, James, L.R.C.S. *Edin.*, Hope Terrace, Glebe Road.
1876		Drake, William Hedley, Sherwood Scrubs, Parramatta.
1873		Du Faur, Eccleston, F.R.G.S., Lands Office.
1876		Eales, John, Duckenfield Park, Morpeth.
1876		Egan, Myles, M.R.C.S. *Eng.*, 2, Hyde Park Terrace, Liverpool-street.
1874		Eichler, Charles F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, Bridge-street.
1876		Eldred, W. H., 119, Castlereagh-street.
1878		Ellis, Thomas Augustus, C.E., 132, Pitt-street.
1876		Evans, George, solicitor, Pitt-street.
1876		Evans, Owen Spencer, M.R.C.S. *Eng.*, Darling-street, Balmain.
1877		Fache, Charles James, Cleveland House, Redfern.
1877		Fairfax, Edward R., 177, Macquarie-street.
1868		Fairfax, James R., *Herald* Office, Hunter-street.
1876		Firth, Rev. Frank, Wesleyan Parsonage, Waverley.
1874		Fischer, Carl F., M.D., F.L.S., Soc. Zool. Bot. Vindob. Socius., 251, Macquarie-street.
1876		Fisher, Chas. Marshall, 132, Pitt-street.
1876		†Fitzgerald, R. D., F.L.S., Surveyor General's Office.
1856		Flavelle, John, George-street.
1863		Fortescue, G., M.B. *Lond.*, F.R.C.S., F.L.S., Lyons' Terrace.
1877		Fraser, A. C., 235, Albion-street.
1878		Fraser, Robert, 12, Barrack-street.
1875		Frazer, Hon. John, M.L.C., York-street.
1876		Frean, Richard, M.R.C.S. *Eng.*, Sydney Infirmary.
1876		Freehill, Bernard Austin, 130, Elizabeth-street.
1878		Fry, Edward H., 5, Verena Terrace, Walker-street, Redfern.
1878		Fuller, Francis John, St. Leonards, North Shore.

Elected.		
1877		Garnsey, Rev. C. F., Christ Church Parsonage, Sydney.
1868	P 1	Garran, Andrew, LL.D. *Syd.*, *Herald* Office, Hunter-street.
1877		Garvan, J. P., 130, Elizabeth-street, Sydney,
1878		Gedye, Charles Townsend, Eastbourne, Darling Point.
1878		George, Hugh, *Sydney Morning Herald* Office.
1876		George, W. R, 172, Castlereagh-street.
1878		Giblin, Vincent W., Australian Joint Stock Bank, Sydney.
1876		Gilchrist, W. O., Elizabeth Bay.
1875		Gilliat, Henry Alfred, Australian Club.
1876		Gillman, Thomas Henry, B.A., C.M., M.D., Queen's Univ. *Irel.*, Mast. Surg. Queen's Univ. *Irel.*, 1, Clarendon Terrace, Hyde Park.
1876		Gipps, F. B., 134, Pitt-street.
1878		Goddard, William C., The Exchange, New Pitt-street.
1859		Goodlet, John H., George-street.
1876		Goode, George, M.A., M.D., M. Ch., Trin. Coll., *Dub.*, Enfield House, Camden.
1876		Graham, Hon. Wm., M.L.C., Stratheam House, Waverley.
1873		Greaves, W. A. B., Armidale.
1878		Griffiths, Frederick C., Macquarie-street.
1877		Griffiths, G. Neville, The Domain, Sydney.
1875		Grundy, F. H., 183, Pitt-street.
1877		†Gurney, T. T., M.A. *Cantab.*, Fellow of St. John's College, Cambridge, Professor of Mathematics and Natural Philosophy, University of Sydney.
1864		Hale, Thomas, Gresham-street.
1878		Hall, Richard T., Seaton House, Crown-street, Surry Hills.
1874		Hardy, J., Hunter-street.
1877		Hargrave, Lawrence, 94, Upper William-street.
1877		Harrison, L. M., Bell's Chambers, Pitt-street.
1878	P 1	Hart, Ludovico, Government Printing Office.
1878		Haviland, E. Cyril, Civil Service, Five Dock.
1877		Hawkins, H. S., M.A., Balmain.
1874		Hay, The Hon. Sir John, K.C.M.G., M.L.C., M.A. *Glasgow*, President of the Legislative Council, Rose Bay, Woollahra.
1876		Heaton, J. H., *Town and Country* Office, Pitt-street.
1875		Helsham, Douglass, York's Terrace, Glebe.
1877		Henry, James, 754, George-street.
1878		Herborn, E. W. L., Victoria-street, Darlinghurst.
1878		Herborn, Eugene, 318, Victoria-street, Darlinghurst.
1876		Heron, Henry, solicitor, 49, Hunter-street.
1878		Hewett, Thomas Edward, Observatory, Sydney.
1859		‡Hill, Edward S., C.M.Z.S., Rose Bay, Woollahra.
1877		Hindson, Lawrence, Careening Cove, North Shore.
1876	P 1	Hirst, Geo. D., 379, George-street.
1878		Hodgson, Rev. E. G., M.A. *Oxon.*, S.C.L., Vice-Warden of St. Paul's College, University.
1868		Holt, The Hon. Thomas, M.L.C., The Warren, near Sydney.

Elected.		
1876		Holroyd, Arther Todd, M.B. *Cantab.*, M.D. *Edin.*, F.L.S., F.Z.S., F.R.G.S., Master-in-Equity, Sherwood Scrubs, Parramatta.
1870	P 1	Horton, Rev. Thomas, Ina Terrace, Woollahra.
1877		Hume, J. K., Cooma Cottage, Yass.
1878		Hunt, Robert, F.G.S., Deputy Master of the Royal Mint, Sydney.
1876		Icely, Thos. R., Carcoar.
1877		Innes, Sir J. George L., Knt., Darlinghurst.
1878		Jackson, Arthur Levett, Government Printing Office.
1876		Jackson, Henry William, L.R.C.S. *Edin.*, Lic. R. Phys., *Edin.*, 130, Phillip-street.
1876		Jenkins, Richard Lewis, M.R.C.S., Nepean Towers, Douglass Park.
1874		Jennings, P. A., Edgecliffe Road, Woollahra.
1877		Jennings, W. E., B.A., Mining Department, Sydney.
1876		Jones, James Aberdeen, Lic. R.C. Phys. *Edin.*, Booth-street, Balmain.
1876		Jones, Richard Theophilus, M.D. *Sydn.*, L.R.C.P. *Edin.*, Ashfield.
1867		†Jones, P. Sydney, M.D. *Lond.*, F.R.C.S. *Eng.*, College-street.
1877		Jones, Edward Lloyd, 345, George-street, Sydney.
1874		Jones, James, Bathurst-street.
1877		Jones, Griffith Evan Russell, B.A., *Syd.*, 382, Crown-street, Surry Hills.
1863		Josephson, Joshua Frey, F.G.S., District Court Judge, Enmore Road, Newtown.
1876	P 1	Josephson, J. P., 253, Macquarie-street North.
1878		Joubert, Numa, Noumea.
1873		Keele, Thos. Wm., Harbours and Rivers Department, Phillip-street.
1877		Keep, John, Broughton, Leichhardt.
1873		Kennedy, Hugh, B.A. *Oxon.* Registrar of the Sydney University.
1874		King, Philip G., William-street, Double Bay.
1877		Kinloch, John, M.A., Hurlstone College, Ashfield.

Elected.		
1878		Knaggs, Saml. J., M.D., Newcastle.
1877		Knox, Edward, jun., Fiona, Double Bay.
1874		Knox, George, M.A., *Cantab.*, King-street.
1875		Knox, Edward, 24, Bridge-street.
1877		Kopsch, G., Telegraph Department.
1878		Kretschmann, Joseph ; care of Mr. Moss, Hunter-street.
1878		Kyngdon, F. B., 221, Darlinghurst Road.
1878		Kyngdon, Fred. H., M.D. *Aberdeen ;* L.S.A., *L. ;* M.R.C.S., *E. ;* C.M., *Aberdeen*, North Shore.
1867	P 8	Lang, Rev. John Dunmore, D.D., M.A. *Glasgow*, Jamison-street. *Obiit* August 8, 1878.
1876		Langley, W.E., *Herald* Office, Sydney.
1874	P 1	Latta, G. J., O'Connell-street.
1876		Laure, Louis Thos., M.D. Surg. Univ. *Paris*, 138, Castlereagh-street.
1859	P 5	†Leibius, Adolph, Ph. D. *Heidelberg*, Senior Assayer to the Sydney Branch of the Royal Mint, *Hon. Secretary.*
1874		Lenehan, Henry Alfred, Sydney Observatory.
1872	P 9	†Liversidge, Archibald, F.C.S. ; Fel. Inst. Chemistry of Gt. Brit. and Irl. ; F.G.S. ; F.L.S. ; F.R.G.S. ; Assoc. Roy. Sch. Mines, *Lond. ;* Mem. Phy. Soc. London ; Mem. Mineralogical Soc. Gt. Brit. and Irel. ; Cor. Mem. Roy. Soc. Tas. ; Cor. Mem. Senckenberg Institute, Frankfurt ; Cor. Mem. Soc. d'Acclimat. Mauritius ; Hon. Fel. Roy. Hist. Soc. Lond. ; Mem. Min. Soc. of France ; Professor of Geology and Mineralogy in the University of Sydney, *Hon. Secretary*, Union Club.
1875		Living, John, Marsaloo, North Shore.
1874		Lloyd, George Alfred, F.R.G.S., O'Connell-street.
1876		Lord, The Hon. Francis, M.L.C., North Shore.
1877		Lord, George Lee, Woolloomooloo.
1878		Low, Hamilton, 139, Phillip-street.
1876		M'Carthy, W. F., solicitor, Pitt-street.
1876		M'Culloch, A. H., jun., 165, Pitt-street.
1874		M'Cutcheon, John Warner, Assayer to the Sydney Branch of the Royal Mint.
1878		MacDonald, Ebenezer, Oriental Bank, Sydney.
1859		MacDonnell, William, George-street.
1868		MacDonnell, William J., F.R.A.S., George-street.
1877		MacDonnell, Samuel, 326, George-street, Sydney.
1876		M'Guire, W. H., Telegraph Office, George-street.

Elected.		
1876		M'Kay, Dr., Church Hill.
1878		‡MacPherson, Rev. Peter, M.A., Bank-street, East Maitland.
1872		Mackenzie, John, F.G.S., Examiner of Coal Fields, Newcastle.
1874		Mackenzie, W. F., M.R C.S., *Eng.*, Lyons' Terrace.
1876		Mackenzie, Rev. P. F., Friendville, Paddington.
1876		Mackellar, Chas. Kinnard, M.B., C.M., *Glas.*, Lyons' Terrace.
1876		Maclaurin, Henry Norman, M.A., M.D. Univ. *Edin.*, Lic. R. Coll. Sur. *Edin.*, 187, Macquarie-street.
1878		Maitland, Duncan Mearns, junior.
1873		Makin, G. E., Berrima.
1878		Mallarky, Stephen, Government Printing Office.
1877		Mann, John, Neutral Bay.
1873	P 4	Manning, James, Milson's Point, North Shore.
1876		Manning, Frederick Norton, M.D. Univ. *St. And.*, M.R.C.S. *Eng.*, Lic. Soc. Apoth. *Lond.*, Gladesville.
1869		Mansfield, G.A., Pitt-street.
1878		Markey, James, L.R.C.S., *Irel.*, L.R.C. Phys., *Edin.*, Regent-street.
1878		Marklove, Robert J., 52, Pitt-street.
1872		Marsden, The Right Rev. Dr., Bishop of Bathurst, Bathurst.
1876		Marsh, J. M., Edgecliff Road, Woollahra.
1876		Marshall, George, M.D. Univ. *Glas.*, Lic. R. Coll. S. *Edin.*, Lyons' Terrace.
1876		Martin, Rev. George, Princes-street.
1875		Mathews, R. H., Mundoorran.
1878		Meilhan, Jules, Victoria Terrace, Victoria-street.
1877		Merriman, James, Mayor of Sydney.
1868		Metcalfe, Michael, Bridge-street.
1873		Milford, F., M.D. *Heidelberg*, M.R.C.S. *Eng.*, 3, Clarendon Terrace, Hyde Park.
1876		Milford, S. F. F., Lands Office.
1876		Millard, Rev. Henry Shaw, Newcastle Grammar School.
1875		Moir, James, Margaret-street.
1875	P 1	†Montefiore, E. L., Macleay-street.
1876		Montefiore, George B., F.G.S., 5, Gresham-street.
1878		Montefiore, Octavius L., Belgian Consul, Gresham-street.
1856	P 2	†Moore, Charles, F.L.S., Director of the Botanic Gardens, Botanic Gardens, *Vice-President.*
		Morehead, R. A. A., 30, O'Connell-street.
1872		Morgan, Cosby William, M.D. *Brussels*, L.R.C.P. *Lond.*, 137, Castlereagh-street.
1876		Morgan, Allan Bradley, M.R.C.S. *Eng.*, Lic. Mid. Lic. R. Coll Phys. *Edin.*, Ashenhurst, Burwood.
1876		Morgan, T. C., L.R.C.S. *Edin.*, M.K. & Q. Coll. Phys. *Ireland*, 137, Castlereagh-street.
1878		Morton, Rev. Canon, St. Peter's Parsonage, Woolloomooloo.
1865	P 1	Morrell, G. A., C.E., Pitt-street.
1877		Morris, William, F.F.P.S. *Glas.* & F.R.M.S.L., 5, Carlton Terrace, Wynyard Square, Sydney.
1877		‡Mullens, Josiah, F.R.G.S., 34, Hunter-street.
1865		Murnin, M. E., Eisenfels, Nattai.
1876		Murray, W. G., 52, Pitt-street.
1876		Myles, Chas. Henry, Wymela, Burwood.

Elected.	
1876	Neild, John Cash, M.D. & C.D., *Berlin*, M.R.C.S. *Eng.*, Lic. Soc. Apoth. *Lond.*, Elizabeth-street, Sydney.
1873	Neill, William, City Bank, Pitt-street.
1874	Neill, A. L. P., City Bank, Pitt-street.
1878	Newton, John, Darling Point.
1874	Nichol, D., 12 Barrack-street.
1876	Nilson, Aroid, Department of Mines.
1873	Norton, James, solicitor, Elizabeth-street.
1875	Nott, Thomas, M.D. *Aberdeen*, M.R.C.S. *Eng.*, Ocean-street, Woollahra.
1878	Nowlan, John, Union Club and West Maitland.
1878	Ogilvy, James L.,Oriental Bank, Sydney.
1877	Olley, Rev. Jacob, Manly.
1875	O'Reilly, W. W. J., M.D., M.C., Q. Univ. *Irel.*, M.R.C.S., *Eng.*, Liverpool-street.
1875	Owen, The Hon. Robert, M.L.C., 88, Elizabeth-street.
1875	Palmer, J. H., Legislative Assembly.
1876	Parbury, Chas., Union Club.
1876	Parrott, Thomas S., Ashfield.
1861	Paterson, Hugh, Macquarie-street.
1878	Paterson, Hugh, junr., 247, Macquarie-street.
1877	Paterson, James A., Union Bank, Pitt-street.
1878	Paterson, Alexander, M.D., M.A., Hillcrest, Stanmore Road.
1877	Pedley, Perceval R., 1, Carlton Terrace, Wynyard Square.
1877	Perkins, Henry A., Pembrook, Johnson-street, Balmain.
1875	Phillip, H., Pacific Insurance Company.
1876	Pickburn, Thomas, M.D. *Aberdeen*, Ch. M., M.R.C.S. *Eng.*, 40, College-street.
1877	Pile, George, 154, Pitt-street,
1878	Poolman, F., Colonial Sugar Refining Co., Bridge-street.
1878	Potts, J. H., Victoria-street, Ashfield.
1862	Prince, Henry, George-street.

Elected		
1876		Quaife, Fredk. Harrison, M.D., Mast. Surg. Univ. *Glas.*, Piper-street, Woollahra.
1876		Quirk, Rev. Dr. J. A., O.S.B., LL.D., *Syd.*, Lyndhurst College.
1878		Quirk, Rev. D. Placid, M.A. (Syd. Univ.), Post Office, Cook's River.
1876		Quodling, W. H., Burwood.
1865	P 1	‡Ramsay, Edward, F.L.S., Curator of the Australian Museum, College-street.
1876		‡Ratte, F., Noumea, New Caledonia.
1878		Read, George H., Secretary to the Attorney General.
1874		Read, Reginald Bligh, M.R.C.S., *Eng.*, Paddington.
1877		Read, Richard, M.D., Singleton.
1868		Reading, E., Mem. Odont. Soc. *Lond.*, Castlereagh-street.
1876		Reece, J. D., Surveyor General's Office.
1870		Renwick, Arthur, M.D. *Edin.*, B.A., *Sydn.*, F.R.C.S. *E.*, 295, Elizabeth-street.
1856		Roberts, J., George-street.
1868	P 3	Roberts, Alfred, M.R.C.S. *Eng.*, Hon. Mem. Zool. and Bot. Soc. Vienna, Bridge-street.
1878		Roberts, William, Australian Club.
1871		Robertson, Thomas, solicitor, 91 Pitt-street.
1872		Robinson, His Excellency Sir Hercules, G.C.M.G., Governor of New South Wales, Government House.
1873		Rogers, Rev. Edward, Rural Dean, Fort-street.
1856	P 6	†Rolleston, Christopher, Auditor General, Castlereagh-street.
1878		Rose, W., Union Club.
1865		Ross, J. Grafton, 24, Bridge-street.
1876		Rowling, Dr., Mudgee.
1864	P 14	†Russell, Henry C., B.A., *Syd.*, F.R.A.S., F.M.S., Hon. Mem. S. Aust. Inst., Government Astronomer, Sydney Observatory, *Hon. Treasurer.*
1875		Sahl, Charles L., German Consul, Consulate of the German Empire, Wynyard Square.
1876		Saliniere, Rev. E. M., Glebe.
1876		Samuel, The Hon. Saul, C.M.G., M.L.C., Gresham-street.
1876		Schuette, Rudolf, M.D., Univ. *Göttingen*, Lic. Soc. Apoth. *Lond.*, 10, College-street.
1856	P 1	‡Scott, Rev. William, M.A. *Cantab.*, Hon. Mem. Roy. Soc. Vic., Gunning.
1876		Scott, A. W., M.A. *Cantab.*, Ferndale, South Head Road.

Elected.		
1876		Sedgwick, Wm. Gillett, M.R.C.S., *Eng.*, Newtown.
1877		Selfe, Norman, C.E., Rockleigh, Balmain.
1876		Sharp, James Burleigh, J.P., Clifton Wood, Yass.
1876		Sharp, Henry, Green Hills, Adelong.
1878		Sharp, Revd. W. Hey, M.A. *Oxon.*, Warden of St. Paul's College, University.
1875		Sheppard, Rev. G., Liverpool.
1878		Skinner, J. H., B.A. *Oxon.*, St. Paul's College, University.
1876		Shields, John, M.R.C.S., *Ed.*, Viewforth, Bega.
1875		Slade, G. P., solicitor, Bridge-street.
1877		Slattery, Thomas, Premier Terrace, 169, William-street, Woolloomooloo.
1872		Sleep, John S., 139, Pitt-street.
1877		Sloper, Fredk. Evans, 360, Liverpool-street.
1852	P 5	†Smith, John, The Hon., C.M.G., M.D., LL.D., *Aberdeen*, M.L.C., F.C.S., Hon. Mem. Roy. Soc. Vic., Professor of Physics and Chemistry in the University of Sydney, 193, Macquarie-street, *Vice-President.*
1878		Smith, Marshall, Onebygamba, Newcastle.
1875		Smith, Robt., M.A. *Syd.*, Solicitor, Sydney.
1874		Smith, John M'Garvie, Hunter-street.
1876		Smith, R. S., Surveyor General's Office.
1878		Smith, E. E., Fevereaux, Roslyn-street, Upper William-street, North.
1876		Southey, H. E., Oaklands, Mittagong.
1872	P 1	Stephen, George Milner, B.A., F.G.S., Mem. Geol. Soc. of Germany; Cor. Mem. Nat. Hist. Soc., Dresden; F.R.G.S. of Cornwall; 3 Cambridge Terrace, Newtown Road.
1857		Stephens, William John, M.A. *Oxon.*, 233, Darlinghurst Road.
1876		Stopps, Arthur J., Surveyor General's Office.
1878		Street, John Rendell, Birtley, Elizabeth Bay Road.
1876		Strong, Wm. Edmund, M.D., *Aberdeen*, M.R.C.S., *Eng.*, Liverpool.
1874		Stuart, Alexander, M.L.A., Sydney.
1876		Stuart, Clarendon, Upper William Street South.
1876		Suttor, The Hon. Wm. Henry, M.L.A., Secretary for Mines, Cangoura, Bathurst.
1874		Taylor, Chas., M.D. *Syd.*, M.R.C.S., *Eng.*, Parramatta.
1876		Tayler, William George, F.R.C.S., *Lond.*, 219, Pitt-street.
1862	P 6	Tebbutt, John, F.R.A.S., Observatory, Windsor.
1878		Tennant, E. G., M R.C.S., Bourke-street, Dubbo.
1870	P 1	Thompson, H. A., O'Connell-street.
1875		Thompson, Joseph, Bellevue Hill, Double Bay.
1877		Thompson, Thos. James, Pitt-street, Sydney.
1876		Thomas, H. Arding, Narellan.
1878		Thomas, F. J., Hunter River N.S.N. Co., Market-street.

Elected.		
1876		Thomas, Wm. Smith, M.R.C.S., *Eng.*, Wollongong.
1876		Tibbits, Walter Hugh, Dubbo.
1876		Toohey, J. T., Melrose Cottage, Cleveland-street.
1873		Trebeck, Prosper N., George-street.
1876		Trouton, F. H., A.S.N. Company's Offices, Sydney.
1877		Tucker, G. A., Ph. D., Superintendent, Bay View Asylum, Cook's River.
1868		Tucker, William, Clifton, North Shore.
1875		Tulloh, W. H., Margaret-street.
1875		Turner, G., 3 Fitzroy Terrace, Pitt-street, Redfern.
1874		Vessey, Leonard A., Survey Office.
1876		Voss, Houlton H., Union Club.
1867		Walker, Philip B., Telegraph Office, George-street.
1870		Wallis, William, Moncur Lodge, Potts' Point.
1867		Ward, R. D., M.R.C.S. *Eng.*, North Shore.
1877		Warren, William Edward, M.D., M.R.C.S., 281, Elizabeth street, Sydney.
1876		Waterhouse, J., M.A. *Syd.*, Perkin-street, Newcastle.
1876		Watkins, John Leo, B.A. *Cantab.*, M.A. *Syd.*, Randwick.
1876		Watson, C. Russell, M.R.C.S., *Eng.*, Camden Terrace, Newtown.
1877		Watt, Alfred Joseph, Ashfield, Parramatta Road.
1859	•	Watt, Charles, New Pitt-street.
1876		Waugh, Isaac, M.B., M.C., *T.C.D.*, Parramatta.
1876		Webster, A. S., Union Club.
1867		Weigall, Albert Bythesea, B.A. *Oxon.*, M.A. *Syd.*, Head Master of the Sydney Grammar School, College-street.
1878		Welch, Edward Wm., St. Olives, Bondi.
1878		Westgarth, G. C., solicitor, Pitt-street.
1877		Weston, W. J., Union Club.
1874		White, Rev. James S., M.A., LL.D., *Syd.*, Gowrie, Singleton.
1875		White, Hon. James, M.L.C., Cranbrook, Double Bay.
1877		White, Rev. W. Moore, LL.D., Arthursleigh Terrace, Elizabeth-street.
1876		Windeyer, W. C., M.A., *Syd.*, M.L.A., King-street.
1876		Wise, George Foster, Immigration Office, Hyde Park.
1874		Wilkinson, C. S., F.G.S., Government Geologist, Department of Mines.
1876		Wilkinson, Henry Toller, Department of Mines.
1878		Wilkinson, Rev. Samuel, 5, Argyle Terrace, Pitt-street, Redfern.

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Elected	
1878	Wilshire, James Thompson, C.P.S., Scone.
1876	Williams, Percy Edward, Treasury.
1878	Wise, Henry, Savings' Bank, Barrack-street.
1873	Wood, Harrie, Under Secretary for Mines, Department of Mines.
1877	Woods, T. A. Tenison-, Phillip-street, Sydney.
1876	Woolrych, F. B. W., 194, William-street.
1872	†Wright, Horatio, G. A., M.R.C.S., *Eng.*, Wynyard Square.
1878	Wright, Rev. Edwin H., Dubbo.
1878	Young, Lamont, H. G., Assoc. R. S. Mines, F.G.S., Department of Mines.

Honorary Members.

Elected, August, 1875.

Agnew, Dr., Hon. Secretary, Royal Society of Tasmania, Hobart Town.

Barlee, The Hon. F., late Colonial Secretary of Western Australia.

Bernays, Lewis A., F.L.S., Vice-President of the Queensland Acclimatization Society, Brisbane.

Ellery, Robert F., F.R.S., F.R.A.S., Government Astronomer of Victoria, Melbourne.

Gregory, Augustus Charles, F.R.G.S., Surveyor General of Queensland, Brisbane.

Haast, Dr. Julius von, Ph. D., F.R.S., F.G.S., Government Geologist and Director of the Canterbury Museum, New Zealand.

Hector, James, C.M.G., M.D., F.R.S., Director of the Colonial Museum and Geological Survey of New Zealand, Wellington.

M'Coy, Frederick, F.G.S., Hon. F.C.P.S., C.M.Z.S., Professor of Natural Science in the Melbourne University, Government Palæontologist, and Director of the National Museum, Melbourne.

Müller, Baron Ferdinand von, C.M.G., M.D., Ph. D., F.R.S., F.L.S., Government Botanist, Melbourne.

Schomburgh, Dr., Director of the Botanic Gardens, Adelaide, South Australia.

Waterhouse, F. G., F.G.S., C.M.Z.S., Curator of the Museum, Adelaide South Australia.

Woods, Rev. Julian E. Tenison-, F.L.S., F.G.S., Hon. Mem. Roy. Soc., Victoria, Hon. Mem. Roy. Soc., Tasmania, Hon. Mem. Adelaide Phil. Soc., Hon. Mem. Linnean Soc., &c., Union Club, Sydney.

Elected, 6 *December,* 1876.

Cockle, His Honor Sir James, Chief Justice, M.A., F.R.S., Brisbane, Queensland.

De Koninck, Prof., M.D., Liège, Belgium.

Elected, 1 *May,* 1878.

Walker, Thomas, Yaralla, Concord.

Obituary, 1878.

Elected.

1876. Bennett, Samuel, Little Coogee.
1850. Clarke, Rev. W. B., M.A., F.R.S., F.G S., &c., V.P.
1867. Lang, Rev. John Dunmore, D.D., M.A., Glasgow.
1870. Macafee, A. H. C.

ANNIVERSARY ADDRESS.

By Christopher Rolleston, Esq., Vice-President.

[*Delivered to the Royal Society of N.S.W.*, 1 *May*, 1878.]

Gentlemen,

The absence of our highly esteemed Senior Vice-President must be a subject of great regret to all of you, more particularly when it is known that his absence is not a matter of choice, but of necessity, forced upon him by failing health, and it is especially so to myself, upon whom devolves the duty of opening this year's Session. I may venture to say that nothing has conduced more to the success of the Royal Society, and rendered its meetings at the same time both instructive and popular, than meeting under the presidency of a gentleman of such varied scientific attainments and general mental accomplishments as are concentrated in the person of the Rev. W. B. Clarke.

Whilst the Institution affords ample scope for every class of workers amongst us—for the man of reading as well as the geologist or naturalist—the laborious collector of facts must always hold the first rank amongst us; and foremost in this rank stands the name of our venerable Vice-President, whose researches into the geological formation of this country would fill volumes, and whose contributions to this Society have done so much to illustrate the Natural History of Australia.

In a new country like this, whilst we may not, perhaps, look for great original thinkers or investigators of the calibre of Darwin, Tyndall, or Huxley, we may be well satisfied to have amongst us so accomplished a geologist as Mr. Clarke; and although it may be true that his unobtrusive labours in the field of science have not met with that public recognition to

which, in the opinion of his friends and admirers, their importance entitles them, I venture to suggest that this arises rather from the lack of scientific knowledge amongst us than from any lack of generous sympathy or appreciation of the services which he has rendered to the country. But however this may be, it must be as gratifying to our venerable friend as to ourselves to know that his labours have met with flattering commendation from the most eminent men of science in Europe—that his name has been enrolled in the list of Members of some of the chief Scientific Societies of the Mother Country, and occupies a high place amongst the leading geologists of the day. I should particularly mention the honor conferred upon Mr. Clarke in the year 1876, by the Royal Society of England, in his election to a Fellowship—first, for valuable geological work in classifying the rocks of New South Wales; secondly, for services rendered in the discovery and development of gold-fields; thirdly, for his contributions to knowledge, amounting to upwards of fifty, published since 1826, in the Journals of the Geological and Meteorological Societies, and elsewhere; and, fourthly, for the important part taken by him in the re-founding of the Royal Society of New South Wales, and in the promotion of scientific knowledge in the Colony. Here we have an epitome of Mr. Clarke's valuable labours in the cause of science, as set forth in the "Journal of the Royal Society of England," which stamps him as a man of whom the Colony has reason to be proud.

The spread of a taste for scientific inquiry is one of the leading objects of our Society. With this view the different Sections hold their meetings, and with what degree of success may be gathered from the records of their proceedings published in the Society's Journal for the past year. Doubtless we are all of us, each in his own sphere, anxious to promote this object, and to direct our efforts to make the Institution the vehicle of practical rather than theoretical science. Those who can collect facts will communicate them to the Society, so as to give value and interest to its proceedings; and those who, like myself, have no special scientific knowledge will endeavour to combine those general

scientific facts which may come within the range of their observation, or which can be collected from scientific literature in a form to enliven our meetings, and to make them at the same time both attractive and instructive.

In order, then, to keep alive an interest in all the higher branches of science, we must not allow to pass unheeded the great discoveries and expansions of thought which characterize the age in which we live, and which in Europe as well as in America are traversing the realms of nature at greater depths than have hitherto been sounded, and continually stirring up to greater efforts the inquiring intellects of the master-minds of the present generation. In pursuance of this view, I propose to lay before you to-night a slight sketch of the progress of science during the past year, in those phases of it which will interest not scientific men only, but all who regard with general interest the investigations and discoveries which mark the stirring times in which our lot is cast.

Foremost, I think, in point of interest is the Telephone of Professor Graham Bell, which may be claimed as a British invention. Mr. Bell, a native of Edinburgh, originated the idea whilst enaged in the work of teaching the deaf and dumb to speak, in Boston, United States. His researches began with the production of musical sounds by means of electrical telephony. It is generally supposed that the dumb are mute because they are deaf, and that when they know how to regulate the action of their vocal organs they can articulate with comparative facility. In his attempts to perfect his system of teaching it occurred to Mr. Bell that if, instead of presenting to the eye of his pupils a system of symbols, he could make visible the vibrations of the air, a great step would be gained in teaching them to articulate. To this end Mr. Bell directed all his energies. Employing apparatus by which he had been producing undulatory currents of electricity for the purpose of multiple telegraphy, Mr. Bell attached a rod loosely by one extremity to the uncovered pole of a magnet, and fastened the other extremity to the centre of a

stretched membrane of gold-beater's skin. He supposed that upon speaking in the neighbourhood of the membrane it would be thrown into vibration, and cause the steel rod to make a corresponding motion, thereby occasioning undulations in the electrical current that would correspond to the vibrations in the density of the air during the production of sound; and further, that the change in the intensity of the current at the receiving end would cause the magnet there to attract its rod so as to copy the motion imparted to that at the sending end.

Mr. Bell's first experiments were not altogether successful, but, persevering in his efforts, he at last produced a model which consisted of a permanent magnet with a coil of wire round it, and an iron plate in front, which produced audible results. The vibration of the voice caused the vibration of the iron plate, that vibration produced a current of electricity, the current of electricity caused a variation of power in the magnet in the distant instrument; the variation of power in the distant magnet caused the iron plate in front of the magnet to vibrate, and that vibration produced a sound. Thus the voice was converted into electricity at one end, and electricity became voice at the other end.

Such was the instrument that Mr. Bell sent to the Centennial Exhibition at Philadelphia, and the following is the official report of Sir William Thomson upon it:—" Mr. Alexander Graham Bell exhibits apparatus by which he has achieved a result of transcendent scientific interest—the transmission of spoken words by electric currents through a telegraph wire. To obtain this result, Mr. Bell perceived that he must produce a variation of strength of current in the telegraph wire as nearly as may be in exact proportion to the velocity of a particle of air moved by the sound, and he invented a method of doing so—a piece of iron attached to a membrane, and thus moved to and fro in the neighbourhood of an electric-magnet—which has proved perfectly successful. The battery and wire of this electro-magnet are in circuit with the telegraph wire and the wire of another electro-magnet at the receiving-station. This second electro-magnet has

a solid bar of iron for core, which is connected at one end by a thick disc of iron to an iron tube surrounding the coil and bar. The free circular end of the tube constitutes one pole of the electro-magnet, and the adjacent free end of the bar core the other. A thin circular iron disc, held pressed against the end of the tube by the electric-magnetic attraction, and free to vibrate through a very small space without touching the central pole, constitutes the sounder by which the electric effect is reconverted into sound. With my ear pressed against this disc I heard it speak distinctly several sentences. * * * I need scarcely say I was astonished and delighted; so were others, including some judges of our group who witnessed the experiments and verified with their own ears the electric transmission of speech. This, perhaps, the greatest marvel hitherto achieved by the electric telegraph, has been obtained by appliances of quite a homespun and rudimentary character. With somewhat more advanced plans and more powerful apparatus, we may confidently expect that Mr. Bell will give us the means of making voice and spoken words audible through the electric wire to an ear hundreds of miles distant."

Inspired by so flattering a verdict, Mr. Bell returned to his experiments with renewed enthusiasm, and in 1877 he subjected his instrument to a series of experiments in America, of which, if not greatly exaggerated, the accounts we have received are perfectly astounding. We read of concerts being heard at places forty-three miles distant, and telephonic communication being carried on between Boston and New York, a distance of 250 miles. The first practical application of the telephone is stated to have been made in May, 1877, by the Water Board of Cambridge, in the State of Massachusetts, who established telephonic communication with the waterworks at Freshpond, in order to facilitate the sending of messages. Now more than 500 houses in New England hold telephonic communication, and more than 3,000 telephones are said to be in operation in the United States.

The invention was introduced into England last year, where it has received marked attention. Telephonic communication has been established between the mainland and Jersey. Several business houses have been connected with the private residences of their principals, whilst at the Prescott Colliery, near Liverpool, remarkable success has attended some experiments made under the superintendence of Sir W. Thomson. In these experiments 600 yards of ordinary electric wire were used, the end in one instance being at the bottom of the pit, while the other end, to which the tubes or trumpet-like orifices, which resemble ordinary stethoscopes, were attached, were brought into the office of the Company, some distance from the pit's mouth. While one of the Government Colliery Inspectors and others went to the bottom of the pit, the majority of the audience remained in the office. Complete success crowned the experiment—which was merely to test the telephone as a means of communication. Questions asked in the office were answered instantaneously from the pit—even the cheering of the colliers at a distance from the instrument was distinctly heard. The telephone was afterwards applied to test the ventilation of the mine, and so adjusted in connection with the air-measurer in the mine, that the overseer above ground could ascertain at once at what rate of current the air was running in the mine. It is hardly possible to conceive a greater benefit to colliers than this discovery entails. Sir William Thomson expressed his own amazement at the great improvement which the instrument had undergone since he tested it at Philadelphia, and stated that if such admirable results had been accomplished by the telephone while still in embryo, what may not be hoped from the future?

At the meeting of the British Association in Plymouth, in August last, Professor Graham Bell himself explained the processes by which the telephone had been brought to its present state. He stated that it had been evolved from a study of the mechanism of the human ear. What ultimate form it might yet assume he did not know; it was as yet only in its embryo state; experiments and investigations were still being carried on by

himself and other scientific friends. Mr. Preece conducted some experiments on the same occasion by placing the meeting in connection with the Guild Hall, and in a very short time a verse of "God save the Queen," as played on a harmonium, was distinctly heard. A song, with chords, was afterwards played, which was clearly heard by numbers of the audience seated near this instrument. But Mr. Bell stated in reply to a question that the report that a concert had been heard in America by means of the telephone was not correct. We may not unreasonably hope that our able Superintendent of Electric Telegraphs will favour this Society with some experiments in connection with this remarkable instrument during the course of the present session.

In the month of December Professor Tyndall communicated to the Royal Society the results of certain experiments made by him in relation to "spontaneous generation," which had been confirmed by further experiments during a summer residence in the Alps. This question has for years been one of interest and experiment by men of science; but it appears now to be determined that the theory of spontaneous generation of infusoria—the lowest forms of which, called bacteria, are the known agents of putrefaction—must be abandoned. The method by which boiling has been employed to destroy germs in the infusion used has been thoroughly tested. The difficulty of killing germs in the infusions, and the difficulty of being sure that the infusions were opened in air free from germs, appear to have led to the belief in spontaneous generation and to the early mistakes in connection with the subject. In a lecture before the Royal Institution, in June last, Professor Tyndall showed that oxygen was necessary to the life of these low organisms. Hence the idea of sterilizing the infusions by depriving them of air. This was done with perfect success. Subjecting an infusion for four or five hours to the action of the Sprengel pump, and afterwards to one minute's boiling, with a view to extinguish its already expiring life, germs were completely destroyed. A minute thus accomplished what three hundred minutes in the

presence of air had failed to accomplish. Nor is the effect here mentioned to be ascribed to a mere suspension of the life of the germs. They are deprived of life when they are deprived of air; for when after a sufficient time germless air is restored to the infusions it fails to revive them. There is a singular similarity between the vital actions of these lowest organisms and those of the highest. Privation of oxygen stifles both high and low, and excess of oxygen poisons both. Professor Tyndall concludes by saying that he is led inexorably to the conclusion that no evidence of "spontaneous generation" exists, and that in the lowest as in the highest of organized creatures the method of nature is that life shall be the issue of antecedent life. A perusal of Professor Tyndall's paper on the subject, contributed to the *Nineteenth Century Review*, in January last, will well repay any one who will take the trouble to look it up. Professor Sanderson, who at one time favoured the belief in the possibility of spontaneous generation, has since announced himself as entirely in accord with Professor Tyndall on the general question.

The important researches of Mr. Dallinger and Mr. Drysdale on the origin and development of minute and low forms of life, which were communicated by Mr. Dallinger to the Royal Institution in May last, being closely allied to the question of spontaneous generation, call for passing notice. After years of special training for the work, these gentlemen watched in turns through a powerful microscope the whole life and reproduction of a monad. The largest specimens examined by them were the one-thousandth of an inch when young, and four-thousandths of an inch when adult. The spores were so small that it required a magnifying power of 5,000 diameters to see them as they began to grow. Among other points of interest, they observed that while it was possible for monads to live with a gradual change of temperature from 45° to 125°, any sudden increase of heat was fatal; and that, whilst adults could stand 140°, the spores could live for ten minutes in a temperature of 300°.

In December last, Professor Stokes communicated to the Royal Society some of the latest investigations of the radiometer, and set

forth in his paper the many difficulties which surround the problem —a problem which, involving the consideration of so many apparent anomalies, seems to suggest the need for re-examination of some of the accepted theories in physics. Most of us are familiar with the small glass vacuum bulbs enclosing the rotating discs, which are shown in the windows of philosophical instrument makers, and no doubt many have noticed the greater rapidity of rotation when much light is thrown upon them than when there is little light. When the instrument was first invented it was thought to be conclusively shown that the rotation resulted from a hitherto unknown mode of action of light. The fact that the light of a candle would cause a radiometer to rotate, even when the light was passed through a solution of alum, which is believed to stop all radiant heat, was put forward as a triumphant proof that an important discovery with regard to light had been made. A multitude of experiments were, however, soon brought to demonstrate that heat unaccompanied by light would produce the same results. The theory of the mechanical action of light had therefore to be given up, and many and various experiments were made to solve the question of "repulsion resulting from radiation." Mr. Stoney gave the results of his experiments to the Royal Society in connection with the question; and subsequently Mr. Crookes, in April, 1877, exhibited to the same Society a form of radiometer differing so far from the ordinary instrument that he proposed to give to it the name of "otheoscope." In the radiometer the alternate sides of the discs of the fly are bright and dark; in the otheoscope the heater is stationary, and the cooler rotates. In the radiometer the glass bulb is an essential part of the machinery, for without it the fly would not move. In the otheoscope Mr. Crookes believes it is only useful to preserve the requisite amount of rarefaction. The unsolved mysteries which still enshroud it give to the radiometer an interest second to none amongst the scientific problems of the present day.

I dare say most of you may remember the visit of H.M.S. "Challenger" to this port, and some of you may

have had the pleasure of becoming acquainted with Mr. Moseley, the naturalist, on board that ship. In the early part of the past year that gentleman published a very interesting paper on the colouring matter of various animals, especially of deep sea forms, in which are mentioned some interesting facts referring to light in ocean depths. At a depth of 60 fathoms it has been proved that light has no effect on sensitized paper, and it is considered probable that at a depth of from 1,000 to 2,000 fathoms solar light has no effect. At a depth of 450 and 490 fathoms respectively, two blind decapod crustaceans were dredged up in the "Challenger" expedition; and other forms without the eyes possessed by their shallow water congeners were found at various depths. Other animals, however, living in very deep water, were found to have very large eyes; hence it seems to Mr. Moseley fair to infer that some kind of light must exist. He mentions that all the deep-sea alcyonarians dredged up were highly phosphorescent, and suggests that there are probably large areas peopled by these; so that there may probably be illuminated patches in the ocean with dark tracts between. He further threw out this interesting idea,—that it is quite conceivable that animals may exist to which obscure heat rays may be visible, and to such even men and animals generally would appear constantly luminous.

The periodicity of Indian famines has been another subject of importance which has engaged the attention of the learned in investigations of this nature. The question between these and the sun spot period has been discussed, but the theory has yet to be worked out to a practical conclusion. The theory is that the rainfall rises and falls as the sun spots increase or decrease, and that the minimum of the solar spots is the period of the maximum sun heat, which prevents the atmospheric water supply condensing into rain clouds. A trained observer has been sent out to India to arrange for the taking of daily photographs of the sun, and we may know more by and by as to the merits of this problem. This is a question so full of interest to ourselves that I dare say our own able and indefatigable

Astronomer may have had his attention directed to the subject; and if so we may hope to be favoured with the results of his observations before the present session of our Society closes.

The Astronomer Royal has during the past year issued a report on the Transit of Venus Expeditions, and intimated that when the photographs of this transit have been measured and worked out another report may be required. The observations of our own Astronomer were, it is well known, amongst the most valuable of the contributions offered towards the solution of the problem of the earth's distance from the sun, and the result of the working-out of the calculations gives the mean distance as equal to 93,300,000 miles.

Mr. Romane's observations on the nerves of jelly-fish, communicated to the Royal Institution in May last, were a valuable contribution in the direction of our knowledge on the evolution of nerve and nerve systems, possessing additional significance when considered in connection with Mr. Herbert Spencer's "Principles of Psychology"; whilst the studies of Mr. Osborne Reynolds, on vortex motions in fluids, which were communicated to the Physical Society, and which may be illustrated by puffing rings of smoke into the air, will, it is believed, when further carried out, afford many valuable data in shipbuilding, as well as in other ways. His communication to the British Association "On the difference of the steering of steamers with the screw reversed when under full way and when moving slowly," is specially valuable to such a maritime country as Great Britain.

But I must not attempt to pursue this interesting inquiry further to-night. It would be impossible within the limits of an address of this kind to follow out and bring under notice the progress that has been made in all the departments of science in the Mother Country, and I must now return to matters of local concern calling for notice at my hands. In the first place, I should call attention to the work that has been done by our own Sections towards the promotion of the

scientific objects of the Society. It is both interesting and important, covering as it does the fields of—1. Astronomy and Physics; 2. Chemistry and Mineralogy; 3. Geology and Palæontology; 4. Botany; 5. Microscopical Science; 6. Geography and Ethnology; 7. Literature and Fine Arts; 8. Medical Science; 9. Social and Sanitary Science. Good work has been done in nearly all of these Sections, for particulars of which I must refer you to the Journal of the Society.

In addition to the interesting address delivered by your late Vice-President (Mr. H. C. Russell) at the opening of the session of 1877, seventeen papers were communicated to the Society, which will be found at length in the Journal of the Society's proceedings. Of these papers perhaps the most noteworthy are those of Mr. Tenison Woods:—1st. On "the Tertiary Deposits of Australia." 2nd. On "the palæontological evidence of Australian Tertiary formation"; and 3rd. On "some Australian Tertiary Corals." And next to these, the two papers by the Rev. W. B. Clarke, on "*Dromornis australis*, a new fossil gigantic Bird of Australia," and "*Sthenurus minor*, a new fossil extinct species of Kangaroo,"—as illustrative of the geological history of animal forms long since passed away—are full of interest to the palæontologist. Professor Huxley, in a lecture delivered at the Royal Institution last year on "the History of Birds," says that there is not one of the distinctive characteristics of birds as they now exist but has to be given up as a characteristic in looking at fossil forms. How true this may be of the fossil remains discovered in Australia further researches may be necessary to determine. He further says that the discoveries to which he alluded, if they did not indicate the actual gradation between birds and reptiles, did show the intermediate forms that had existed.

The report of the Council which has been read to you by the Honorary Secretary, dealing, as it does most fully, with all the details of the Society's position and progress during the past year, relieves me of the duty of laying

these matters before you; but I cannot help noticing the munificent gift of Mr. Thomas Walker towards the Building Fund of our contemplated new Home. This instance of liberality on the part of a gentleman not bound to us by membership ought to animate us with greater zeal in the cause we have in hand, and instigate us to greater efforts to secure for the Society a permanent habitation.

In his last address the Rev. W. B. Clarke laid great stress upon the obtaining of a Charter for the Society, and I may venture to say that the announcement that has been made to-night will afford to him in his sick room the pleasing prospect of a speedy accomplishment of his aspirations in that behalf. Whether the Home should precede the Charter or the Charter should precede the Home has been a moot point amongst us. We now see an early prospect of obtaining the one, and can have no difficulty, I apprehend, whenever we see fit to apply for it, in obtaining the other. But whilst the one and the other will give stability to the Society, we must never forget that, upon the individual efforts of its members to collect facts and to supply information in a manner to attract attention and to stimulate thought and discussion, rest the popularity, the usefulness, and the success of the Institution.

And now gentlemen, before closing this address, I will ask you to favour me with your further attention for a few minutes, whilst I submit to your notice a very remarkable and interesting piece of information contributed by Mr. Henry Bessemer to the *Times* newspaper, in the month of January last. It is headed 'A Billion dissected." Few, if any of us, are I dare say aware of the vastness of the quantity expressed in that little word, and, as I have not seen the information reproduced in this Colony, I make no apology for appending it to my address, being assured that you will not grudge the time occupied in listening to its very remarkable revelations.

He says: "It would be curious to know how many of your readers have brought fully home to their inner consciousness the

real significance of that little word 'billion' which we have seen of late so glibly used in your columns. There are, indeed, few intellects that can fairly grasp it and digest it as a whole; and there are, doubtless, many thousands who cannot appreciate its true worth even when reduced to fragments for more easy assimilation. Its arithmetical symbol is simple and without much pretension; there are no large figures—just a modest 1 followed by a dozen ciphers, and that is all. Let us briefly take a glance at it as a measure of time, distance, and weight.

"As a measure of time, I would take one second as the unit, and carry myself in thought through the lapse of ages back to the first day of the year 1 of our era, remembering that in all those years we have 365 days, and in every day just 86,400 seconds of time. Hence, in returning in thought back again to this year of grace 1878, one might have supposed that a billion of seconds had long since elapsed; but this is not so. We have not even passed one-sixteenth of that number in all these long eventful years, for it takes just 31,687 years 17 days 22 hours 45 minutes and 5 seconds to constitute a billion of seconds of time.

"It is no easy matter to bring under the cognizance of the human eye a billion objects of any kind. Let us try in imagination to arrange this number for inspection, and for this purpose I will select a sovereign as a familiar object. Let us put one on the ground and pile upon it as many as will reach 20 feet in height; then let us place numbers of similar columns in close contact, forming a straight line, and making a sort of wall 20 feet high, showing only the thin edges of the coin. Imagine two such walls running parallel to each other and forming, as it were, a long street. We must then keep on extending these walls for miles—nay, hundreds of miles, and still we shall be far short of the required number. And it is not until we have extended our imaginary street to the distance of 2,386½ miles that we shall have presented for inspection our one billion of coins.

"Or in lieu of this arrangement we may place them flat upon the ground, forming one continuous line like a long golden chain, with every link in close contact. But to do this we must pass over land and sea, mountain and valley, desert and plain, crossing the Equator, and returning around the southern hemisphere through the trackless ocean, retrace our way again across the Equator, then still on and on, until we again arrive at our starting point; and when we have thus passed a golden chain around the huge bulk of the earth we shall be but at the beginning of our task. We must drag this imaginary chain no less than 763 times round the globe. If we can further imagine all these rows of links laid closely side by side and every one in contact with its neighbour, we shall have formed a golden band around the globe just 52 feet 6 inches wide; and this will represent our one billion of coins. Such a chain, if laid in a straight line, would reach a fraction over 18,328,445 miles, the weight of which, if estimated at ¼ oz. each sovereign, would be 6,975,447 tons, and would require for their transport no less than 2,325 ships, each with a full cargo of 3,000 tons. Even then there would be a residue of 447 tons representing 64,081,920 sovereigns.

"For a measure of height let us take a much smaller unit as our measuring rod. The thin sheets of paper on which these lines are printed, if laid flat and firmly pressed together in a well-bound book, would represent a measure of about 1-333rd of an inch in thickness. Let us see how high a dense pile formed by a billion of these thin paper leaves would reach. We must, in imagination, pile them vertically upward, by degrees reaching to the height of our tallest spires; and passing these, the pile must grow higher, topping the Alps and Andes and the highest peaks of the Himalayas, and shooting up from thence through the fleecy clouds, pass beyond the confines of our attenuated atmosphere, and leap up into the blue ether with which the universe is filled, standing proudly up far beyond the reach of all terrestrial things; still pile on your thousands and millions of thin leaves, for we are only beginning to rear the mighty mass. Add millions on

millions of sheets, and thousands of miles on these, and still the number will lack its due amount. Let us pause to look at the neat ploughed edges of the book before us. See how closely lie those thin flakes of paper, how many there are in the mere width of a span, and then turn our eyes in imagination upwards to our mighty column of accumulated sheets. It now contains its appointed number, and our one billion of sheets of the *Times* superimposed upon each other and pressed into a compact mass has reached an altitude of 47,348 miles.

"Those who have taken the trouble to follow me thus far will, I think, agree with me that a billion is a fearful thing, and that few can appreciate its real value. As for trillions and quadrillions, they are simply words, mere words, wholly incapable of impressing themselves on the human intellect."

I think you will all agree with me that the moral conveyed in this communication is not the least interesting nor yet the least instructive feature in it.

Tasmanian Forests: their Botany and Economical Value.

By Rev. Julian E. Tenison-Woods, F.G.S., F.L.S.,
Hon. Mem. Roy. Soc. N.S.W., Victoria, Tasmania, Adelaide Philosophical Soc., &c., &c.

[*Read before the Royal Society of N.S.W.*, 5 *June*, 1878.]

In February, 1874, I visited Tasmania for a missionary tour throughout the island, and for nearly three years traversed its various districts. I had thus an opportunity of becoming acquainted with all the inhabited portions, except the north-west and two or three places on the east coast. I sometimes resided for weeks together in some localities, and on the south coast made frequent journeys on foot amongst the splitters and fishermen on that part of the island. These journeys gave me leisure for observation, and I was able in some small degree to increase the knowledge of Tasmanian natural history. Many of the notes made have been published, and some I hope still to place in an available shape before the public. Some are of a strictly technical character, but some have a more simple and popular aspect. Such, for instance, are the notes made upon the forests and timber resources, and I venture to think it may be worthy of a place in the Royal Society's proceedings if I bring before them what I have been able to note on this subject. It is well known that Tasmania has in its timber one of its very great industrial resources, and a more intimate knowledge of what these are cannot fail to be of service to the public.

Tasmania may be said generally to be a thickly timbered country. With the exception of the table-lands and the slopes between the main ranges and the sea, the soil is usually clothed with forest. But these forests are not the timber-producing forests of the islands. These are confined to a few localities, and are limited in extent. They are only found in the narrow deep gorges and gullies proceeding from some of the highest mountains. They do not appear to be confined to any particular soil, though some of the best are found on modern (Tertiary) basaltic rocks; neither are they confined to any particular height above the sea level. The fine timber near the Mill-house Falls grows in gullies 1,000 feet and more above the sea, while the forests on

the banks of the Huon and Kermandee descend right down to the beach. The aspects of these forests are most peculiar, and quite different from the thickly timbered country of other parts of the island. The vegetation is dense and almost tropical in character. The most conspicuous objects are the tall and tapering blue gum trees, by which name I shall always refer subsequently to the *Eucalyptus globulus*. They grow so close together as quite to shut out the prospect, but so straight and wand-like that the slim lines of bark look like fine ornamental graining. They are of immense height; 200 feet without a branch is not at all uncommon, and there are very many trees ranging from 300 to 400 feet high. Long bands of bark hang down from their sides and across their branches, and these when set in motion by the wind keep up a constant rattle and creaking, filling the gloomy forest with the strangest echoes and sounds. The great height of the trees would never be imagined from the aspect they present. As they always grow on very steep slopes and never crown the summit of the ridges, their height is lost against the adjacent ranges. It is only when standing at the foot of their moss-covered stems, where the roots rise gracefully up around from the buttress-like base, twisting and turning round the bole like massive moorings, that one gets an idea of their enormous size. Far above one's head, twinkling in the daylight, which contrasts so strongly with the sombre green atmosphere around, a moderate tuft of leaves is seen at the summit of the graceful yet massive stem. The branches look nothing beside the butt, and in reality the effect of the crown with the straggling branches and ragged untidy strips of bark is disappointing and insignificant. Here the true rugged character of the *Eucalyptus* asserts itself, which is in the strongest contrast to the regular and so extremely graceful stem. Beside the *E. globulus* there is always a very dense growth of other but smaller trees. In Tasmania it is generally what is called sassafras (*Atherosperma moschatum*), muskwood (*Olearia argophylla*), beech (*Fagus cunninghami*), pine (*Frenela rhomboidea*). Underneath this there is always an almost impenetrable scrub of pear tree (*Pomaderris elliptica*), stinkwood (*Ziera smithii*), varied with fern trees, rarely any other than *Dicksonia antartica*, with an undergrowth of *Lomaria patersoni*, &c. Sometimes the forest is a little changed in appearance by a dense growth of *Bedfordia salicina*, *Olearea rosmarinifolia*, *Senecio lautus*, *australis*, and *velleioides*, *Olearea viscosa** and *glandulosa*, *Aster ramulosus*, &c.; and it is very beautifully covered over with the showy blossoms, or still more showy seed-vessels, of the *Clematis aristata*.

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* It is *O. viscosa* which is said to have a musky odour, but I have never observed it, except on *O. argophylla*.

To a casual observer there seems to be absolutely no difference between these forests and those of the Dividing Range in Victoria; as, for instance, on the Upper Yarra and along the Wood's Point Road, the great bulk of the vegetation is certainly the same. Thus the *Olearea rosmarinifolia*, *Aster stellulatus*, and *ramulosus*, *Pomaderris elliptica* and *Bedfordia salicina* meet the eye on every side. The two last, indeed, almost exclude every other undergrowth, the long narrow stems of the *Pomaderris* forming almost impenetrable thickets on the Black Spur. But the *Eucalyptus*, though identical in aspect and graceful height, is not the same species. *E. amygdalina** taking the place of *E. globulus*, which is the more singular as they are both accompanied by stringy bark trees (*E. obliqua*), which affects the same lofty habit in both localities. The fern tree is different; at least *Dicksonia* is not so common as *Alsophila excelsa;* the other common plants are the same in both places, such as *Olearea argophylla*, *Olearea stellulata*, *Fagus cunninghami*, *Drimys aromatica*, and the common *Lomaria*. A close attention, of course, will reveal a good many differences. One will miss numerous familiar beauties of the Tasmanian forests, and their places will be taken by forms as peculiar and interesting.

This close resemblance is more remarkable if we bear in mind how very distinct and almost complete these forests of Tasmania and Victoria are from those of New South Wales at the east side of the continent. There the *Eucalypti* are different, and the undergrowth of shrubs is almost entirely different. The vegetation is sub-tropical in character; at least as far south as Ulladulla. The gigantic nettle (*Laportea gigas*) and cedar (*Cedrela australis*) take the place of *Fagus cunninghami;* while the fern trees are few in comparison with the stately palms. *Seaforthia elegans* and the cabbage-tree (*Corypha australis*) shoot up continually, high above the brush, and vie in elevation with the elegant turpentine (*Syncarpia leptopetala*) and ironbark (*Eucalyptus siderophloia*). The sub-tropical vines of various descriptions bind the vegetation into massive walls of dark shining green, while the stems of the trees are varied and adorned with immense fronds of the epiphytic ferns (*Asplenium nidus* and *Platycerium alcicorne*), which here reach their perfection. There are some few points of resemblance between the Eastern forests and those of Tasmania. *Olearia argophylla* is found in both, and it is in the New South Wales forests only that its odour of musk is fully developed. In Victoria the scrubs are in some places (on the slopes of Mount Juliet for instance) crowded very thickly with the dense leafy bushes of *Prostanthera*

* This tree, known as peppermint gum, has a poor and worthless character in light soils, but becomes in the shaded gullies of the Dandenong Ranges one of the finest and loftiest trees of the world.

rotundifolia, a labiate of very pretty flowers but most offensive odour, which seems to be given off from a sticky resinous exudation abounding in the branches and leaves. The same shrub is very common in the scrubs of the Illawarra and Shoalhaven districts, equally abundant, and equally offensive. It is found in N. Tasmania, but I never noticed it among the timber-producing forests of Tasmania; indeed there are but few species common to all three. Those found commonly in Victoria and Tasmania are not common in New South Wales, and those common in the forests of the latter Colony are either absent from Tasmania or from Victoria. Of course this is speaking in a general way. There are exceptions, which, however, do not go far beyond those I have mentioned, to which I might add *Leptospernum lanigera*, *Daviesia latifolia*, *D. ulicina*, *Hakea pugioniformis*, *Gleichenia dicarpa*, *G. flabellata*, and a few others.

Before I pass on to the consideration of the timber products I may say a word here as to what I regard as the cause of the singular height and straightness of the Eucalypti in these forests. This is a peculiarity almost restricted to Tasmania and Victoria. The trees grow to a great height in the forests of New South Wales, but nothing like the altitude they attain in the other Colonies. In this respect the greatest height seems to be reached in Victoria. Trees have been felled which measured over 460 feet, and it is common to see them in both Colonies rising 200 feet and more, as straight as an arrow, before sending forth a branch. Now, in what way are we to account for this? First of all it must be observed that we never see this kind of timber except in very deep gullies, where we may say the light is almost shut out by the rich close vegetation, and where the subsoil is probably several feet of a humus composed of decayed wood and leaves. As soon as the seeds of the gum tree germinate they shoot up with extraordinary rapidity. Young stems may be constantly seen 25 to 30 feet in height, and the stem not 2 inches across near the ground. At the top there are only a few leaves, set on small twiggy branches. Some of them can be seen not more than two years old, because they have risen around timber that was quite recently felled. I consider that three causes combine to produce this rapid and straight growth, which might easily be secured in other countries, where this (to my mind the most wonderful) property of the *Eucalyptus* might be developed. One is the extreme richness and moisture of vegetable soil; second, perfect absence of disturbance, even by the wind; third, the comparative obscurity or modified light, which causes this young plant to throw out but few branches or leaves until the light of day is reached, which is often at a height of 100 feet or more above the root. It must be remembered also that in the young state of *Eucalypti*, with few

exceptions, the leaves and young branches are quite of a different pattern and plan from those of the mature tree. The earlier stages fall away and leave the tree still more bare as it grows up. That light and shade and absence of movement are the main causes can be easily seen on the more exposed summits. At Mount Juliet the trees at the base are very lofty, though not the most lofty of the range or equalling those of the Black Spur; but at about 400 feet below the summit the timber becomes stunted and ragged, and those lofty trees on the slope which send these branches thus far partake of the knotted twisted character, and have them all very singularly bent towards the mountain by the prevailing direction of the winds to which they are exposed.

It is a very important fact to ascertain if these views as to the growth of the *Eucalyptus* are correct. There are plenty of deep shady gullies in the mountains of Europe where the experiment might be tried. In Norway and in some of the valleys of the Alps favourable places might very easily be found. I am convinced that the trees are of very rapid growth, and even the largest are not of great age. Cold does not affect them. In many of the gullies of Tasmania the snow lies around the trees for six months of the year or even longer; and in Victoria the same trees are sometimes exposed to a very high temperature. The acclimatization, therefore, ought not to be a matter of great difficulty, neither would much time be required for the experiment. Baron von Mueller assures us in his "Select Plants" that the Eucalypt is much more hardy than the orange or lemon tree.

It is a very interesting inquiry to know how old are the stately trees which people these forests. Judging from their size, one would be inclined to attribute to them great antiquity. I was very anxious to collect data on the subject; but to nearly all my inquiries I only received mere guesses; from 200 to 300 years was the general reply. I found, however, in Mr. Hill, a source of information at once reliable and valuable. Mr. R. Hill is the proprietor of an extensive sawmill at Honeywood, on the Huon; he is also a shipbuilder and hop-grower. It is from him that I have derived the most of the statistical information in the paper, and the facts which did not come under my personal observation: and I take this opportunity of thanking him for his readiness in affording every aid to inquiry, and express the hope that the Colony may long profit by his intelligence, industry, and enterprise. Mr. Hill assured me that some of the gum trees, and perhaps all of them, shed their bark twice in the year. The stringy bark (*E. obliqua*) is one of the most striking instances of this. He further informed me that, hearing a lecture from Mr. Bicheno on the growth of trees, and the statement that a ring of wood was added to the diameter each

year of growth, he was induced to test the truth of this. There was a blue gum tree in his garden in Hobart Town, the age of which he was sure of, as his brother had planted it eighteen years previously. He felled it and counted the rings, and found them to be thirty-six in number, or two for every year. From this, and from the shedding of the bark as described, and a long series of observations, he concludes that the sap rises twice in the year. He has for many years watched the growth of the trees, and he believes that for the first twenty years the average growth is about one inch in diameter for each year. Out of thousands of trees felled or cut in his mill, he has not found one over seventy-five years old, and a very large proportion of the serviceable timber is composed of trees about fifty years of age. Quite recently he has had a very interesting opportunity of verifying these observations. At Ladies' Bay (between Port Esperance and Southport), a paddock on the farm of Mr. D. Rafton was cleared for the purposes of cultivation. It was exactly sixteen years this summer (1877-78) since a crop was taken off it, and was quite overgrown with saplings, which were all cut down. Mr. Hill, at my request, wrote to Mr. Rafton, requesting him to examine the stumps, and I append his reply: "Ladies' Bay, April 26, 1878. According to your request I send you the result of my examination of the stumps of young saplings in the paddock which we are now clearing. Number of rings in the longest saplings, thirty-three; size across the heart-wood where the rings cease, one inch. The rings, I observe, are not an equal distance from each other, some of them being three times the size of the others. On making inquiries I find beyond a doubt that it is exactly sixteen years this summer since the last crop was taken off the paddock.—Yours truly, D. Rafton." From these facts I think we may safely adopt Mr. Hill's conclusion that there are two rings of growth for each year, and that the tallest trees of the forest, the giant timber of Tasmania, range from fifty to seventy-five years old.

I may mention here incidentally two inconveniences to which the Tasmanian forests are subjected. One is the "tick." This is a small insect which lives on the fern leaves. It burrows readily under the skin of any animal upon which it creeps and produces much irritation and inconvenience. It is said sometimes to cause the death of dogs, calves, and goats. I do not know whether the species is the same as that which is found in the fern gullies of New South Wales and Queensland, where the bite is regarded, though erroneously, as almost venomous. The other pest is the abundance of leeches which swarm the undergrowth. After even slight rain they come out in great numbers, and unless a pedestrian takes precautions against them, and keeps a careful watch, they may not only be painful but dangerous in their attacks. A

similar plague used to be common on the open swampy plains of the south-eastern district of South Australia, especially on the Mosquito Plains. Cattle suffered much from them in the long grass, but of late years they have disappeared.

The principal use to which the timber is put is for what is called "sawn stuff," coopers' staves, shingles, and palings. The shingles are for the most part now made by young girls, and they do all the work, even in some instances to the felling of the trees. It is not every tree that will suit for the purpose. It must be a young tree, or "spar" as it is here called, and must be very straight in the grain. This is ascertained by cutting a square block out of the side at about 10 or 15 feet from the ground. A stout young sapling is first cut down. One with a good strong fork is necessary, and thus it is seldom a Eucalypt. It is cut to a length of 18 or 20 feet. A deep notch for a foothold is cut a little below the fork, and it is then rested against the tree which is to be tried. The wood-cutter then climbs to the fork, in which one foot is placed, and the other a little below on the notch. This gives a firm enough footing to wield the axe. The tree is then tried, and if found suitable a stage is erected at a height of 10 or 12 feet from the surface. From this the tree is felled. It not unfrequently happens, however, that the labour is in vain, as the timber is so close around that the tree will not fall—it merely topples over and reclines against its neighbours. The "trying" a great height from the ground and the stage is seldom necessary except for very heavy timber. The "spars" are more easily dealt with; when fallen they are rapidly cut into short lengths with a crosscut saw. The billets are again split with wedges into the requisite width, and then by a rapid series of blows with a wooden mallet and a shingle knife, the shingles are split, two being generally slit with one blow. The shingle knife is first used as a wedge; the handle, which is at right angles to the back of the blade, then is worked as a lever to widen the opening, in which the hand is inserted while the knife is worked down. The wet sap of the wood is full of tannin, with which the iron of the knife combines to make a deep black stain wherever it rests. The poor girls who work at this trade have their hands almost permanently stained a deep inky hue.

Where the useful timber grows the brushwood is always so thick that regular tracks have first to be cut to the places. First of all the owners of the different sawmills run out tramways in various directions for three or four miles. These tramways are of the simplest kind, being merely cross sleepers, on which square wooden rails are pegged down; yet they are rather expensive structures, because of the many bridges that have to be made over the numerous creeks. From various points on these tramways tracks are cut into the thick scrub. First of all a gigantic

gum-tree is cut down, and its stem is used as a bridge over the brushwood, thus leading 300 or 400 feet into the scrub, and often arching some feet above it; from this the track is carried further, either by cutting fresh trees, or by using the stems of fern trees either as flights of steps or pathways. Thus, perhaps, the scrub will be penetrated for half a mile, and the huge and lofty timber will be seen rising on every side. The scene is one of peculiar beauty. Dull green is the light, and the perfect stillness and quiet is disturbed by nothing but the distant rustling of leaves far overhead, the sound of some woodman's axe, or the peculiar cry of the wattle bird (*Anthochæra inauris*), or the loud smack of the whip bird (*Pachycephala glaucura*). The ground is carpeted with bright green moss, elegant brakes and flowers spring up all around, and the brown stems of the fern trees, bearded with *Hymenophyllum* and surmounted with whorls of palm-like fronds, shut in the view on every side, and make the seclusion lovely beyond description. The whole place is, however, dripping with moisture, so that the poor young workers may be said to be always wet through. They make their shingles into bundles of fifty, fastened round with bands of green bark, but as tight and compact as if the whole mass were of stone. This is done by tying up a bundle of somewhat less than the number and then wedging in the remainder. A bundle of fresh wet shingles will weigh from 50 to 60 lbs, yet I have seen young girls of sixteen years of age carrying out two of such bundles on their shoulders. They divide the labour between themselves in this way, that a party of four, often sisters, will have two for splitting and felling and two for "carrying out." They arrange rests or "spells," as they are called, every furlong, where is a small stage of paling about three feet from the ground. The bundle of shingle has a long peg driven into the centre, and two bundles are held together by a cross strap of bark. The "carrier" stoops with her back towards the bundle, raises her hands over her head, and by means of the two pegs tilts the load on to her shoulder and staggers along to the first "spell," where the burden is slid down on the stage for awhile. It is certainly a most unfeminine occupation, and still less is it adapted to comparative children. The splitters are very often utterly uneducated; yet in spite of the way young females are thus exposed in the midst of the remains of an almost entirely ex-convict population, they are simple and innocent and wonderfully accessible to religious impressions and teaching. The boys and girls are able to earn about 2s. 6d. or 3s. a day, while men can make from 6s. to 7s. There seems to be no scarcity of employment, but the supply of labour is at least not less than the demand. Most of the sawmillers keep their own stores, so that most of the wages are taken out in goods; and though the disadvantages

of this are felt on both sides, yet the very few inducements for small capitalists to settle in these wild districts renders this system almost unavoidable.

The larger timber which is useful for heavier purposes than shingles, is treated in a different way. The trees, when they are felled, are cut into lengths of 10, 12, and 14 feet, according to the nature of the "stuff," as it is called. The huge round logs thus resulting are rolled down to the edge of the tramway, or drawn by bullocks on a kind of wheeled sleigh. It is thus brought to the sawmill, where it is speedily cut up into "sawn stuff." The thickness and length of course depend upon the kind of timber required. At the time of the gold fever (1852–3–4), when the timber trade of the Huon reached a prosperity which has never been seen before or since, the demand was enormous. But it could not be cut too light; the thinnest shingles, studs, palings, and battens were sure to meet the readiest sale. The state of the roads to the diggings, and the difficulty of carriage, explain this peculiarity. At the present the trade is very fluctuating, and the supply probably in excess of the demand. The favourite timber used for sawing is stringy-bark (*Eucalyptus obliqua*) and blue-gum (*Eucalyptus globulus*). The former is most in use—first of all because it is more abundant, but probably, also, because it is a softer timber and more "mellow," as they say here, to work. It is preferred for all kinds of carpentry where more strength is required than pine could furnish. But there is a second species of stringy-bark which is called here "gum-topped stringy-bark." I have very little doubt that this is *Eucalyptus virgata*, of Siebold. The Rev. W. W. Spicer has made known its existence in Tasmania, which was not hitherto recorded. It is the "mountain ash" of New South Wales splitters, and occurs in the south-eastern part of this Colony and in Victoria. In South Australia it is a mere twiggy bush 15 to 20 feet high. It is exactly like stringy-bark in the fibrous twisted bark, but it is very much more like the blue gum in the leaf. I never examined the seed-vessels or flowers. The wood is lighter in colour than *Eucalyptus obliqua*, which goes by the name of brown stringy-bark. The "gum-top" is close-grained, and very few are able to distinguish the timber from blue gum. It is much used for shipbuilding purposes.

But for all work where length, strength, and durability are required *Eucalyptus globulus*, or blue gum, is most in demand, It is generally procured by hand sawyers, who cut up the trees where they fall in the forest. Its uses are very various. It is in demand for bridges, railway sleepers, coach and wheelwright work; but to shipbuilders it is invaluable. It makes the very best planking for ships' bottoms. It has the property of swelling under water to such an extent that it becomes a matter of

some difficulty to find the seams when the vessels are put upon the slips for coppering. When properly seasoned it is the best timber for keelsons, keels, ribs, knees, beams, and stringers. But much judgment is required in selecting the timber. All pieces that contain heart-wood or sap-wood must be rejected. These are both worthless and soon decay. The true serviceable blue gum must come from the circumference of the tree, about midway between the bark and centre.

There are other trees used besides these, but they are not the main sources of supply. The celebrated Huon pine (*Dacrydium franklinii*, Hooker) is much in demand, but getting daily more scarce; it is only found in a few remote spots far in the mountain ranges. The sources of the Picton are now the principal localities whence this timber is derived. Another tree, much used for spars, is the celery-topped pine (*Phyllocladus rhomboidalis**); it is much more common than the former. Muskwood (*Olearea argophylla*), dogwood (*Bedfordia salicina*) are used for ornamental purposes with lightwood, or blackwood, for it goes by both names (*Acacia melanoxylon*) she-oak (*Casuarina stricta*), and other trees.

The blackwood (*Acacia melanoxylon*) is largely used for oil-casks, and is the only wood we have in Australia, as far as we know, that is suitable for the purpose. The tree, on good soil and well-watered valleys, reaches a height of 80 feet, with a stem several feet in diameter. It is split into staves 6 by 3 inches thick and 6 feet long, and then shipped from the Tamar to Victoria. The wood is also considered most valuable for furniture, railway carriages, boats, casks, billiard tables, pianos (for sounding boards and actions), and numerous other purposes. Silver wattle (*Acacia decurrens*) is also much used for staves, from 20 inches to 5 feet long; it is shipped in quantity to Victoria, and used for beef and water casks. Trees from 12 to 24 inches in diameter are the usual sizes worked; but they become daily scarcer, from the fact that they are annually destroyed in hundreds of thousands for the sake of the valuable bark. The bark and gum of this tree are becoming highly esteemed because of the many dyeing purposes for which it is found they are almost unequalled. Young trees are still very common, but the time is not far distant when Tasmanian colonists will find it worth their while to cultivate them.

The sassafras (*Atherosperma moschatum*) is found to be very valuable for sash and door work. The myrtle or beech (*Fagus cunninghami*) is equally prized for the same purposes, and indeed all kinds of light joinery. Latterly sash and door

* Besides the Tasmanian tree, which is endemic, there are only two more species of this curious genus known, one in New Zealand and the other in Borneo.

machinery have been introduced into Hobart, and thus these trees have come into much demand among the sawyers, though hitherto they have been in a measure spared. They are both splendid trees, but the beech, for elegance of foliage—that is to say, in shape, denseness, and for colour, which varies in every shade from light orange to a rich dark glossy green—has no equal in Australia. Its elegant sprays of leaves form lovely backings for vases of flowers or greenhouses. It is to be regretted that it is not used more to vary the monotony of the Moreton Bay fig in our streets and parks; it is quite equal to it as a shade-giving tree.

The principal places of export for timber are the Huon district, including Franklin, Honeywood (on the Kermandee), and Port Cygnet; next is Port Esperance, then Southport. All of these employ two or three sawmills, with some at intermediate places. At Recherche Bay there is no mill, but some hand work is done; and the same at Port Davy, which is a very remote district on the extreme south-west of the island. The timber is brought up from these places to Hobart Town in small cutters or "crafts" as they are called, very much like the oyster dredgers or herring ketch of the British Channel.

Quite a flotilla of these small vessels are employed in the trade, and the port of Hobart is principally occupied with them. Were the export trade of timber to fail in Tasmania the harbour would look barren indeed. There is a considerable trade with New Zealand as well as with Australia; the former island sends timber, kauri pine (*Dammara australis*), to Tasmania, and receives hardwood (blue gum and stringy-bark) in return.

The question naturally arises whether the supply of timber is likely to fail. I have had the opinions of some of the most experienced sawmillers, and they were unanimous that the supply is rapidly decreasing. But this arises not so much from the quantity cut as from the absence of timber reserves, where the sawyer could precede the settler. Under the present (1876) Waste Lands' Act of Tasmania, the 24th section binds purchasers to reside for fourteen years upon the ground he selects, and to improve it. He generally chooses where the blue gum grows, as the soil is there of the best description. To fulfil the conditions of the Act, he "rings" all the standing timber—that is, he makes a deep incision all round the tree so that it may die. In about two years the timber is thus rendered utterly worthless, being full of "sun-shakes," as the irregular splitting and weathering is termed. The consequence is, that there is daily greater difficulty experienced in finding suitable trees. If young trees were allowed to grow up to supply those which have been felled, the supply might be considered inexhaustible. But this is not the case. If the ground has been at

all well cleared by the splitter or sawyer it is seized upon by the settler, who grubs the stumps and destroys the saplings, planting in place raspberry canes, currant bushes, and those fruits which, next to timber, form the principal export of the Huon.

Yet, in spite of all these drawbacks, there is still a considerable supply of timber in the forests which can hardly be ever selected, as the scrub is too dense. I am informed that, judging from the area of land worked over in the Huon district for the last thirty years, there is beyond a doubt a supply for fifty years at the same rate of production.

The only way to prevent the wholesale destruction of the timber will be by proclaiming reserves or State forests, as they have done in Victoria. This is what the sawyers and splitters are crying out for, but as yet without effect. I do not undertake to pronounce an opinion on a question which may have political difficulties unappreciable by me; but it does seem a mistaken liberty to allow selectors to settle on land of great value as a timber forest but useless for agriculture, until the whole of the valuable timber is ruthlessly destroyed. It seems to me that as long as any available land can be obtained free from timber, or with timber of little value upon it, no selector should be allowed to destroy the forests. The matter is one which the Legislature should deal with promptly, or the forests of Tasmania, peerless and priceless as they once were, will soon be things of the past.

The Molluscan Fauna of Tasmania.

By the Rev. J. E. Tenison-Woods, F.L.S., F.G.S., Hon. Member Royal Society, N.S.W., &c., &c., &c.

[*Read before the Royal Society of N.S.W.*, 4 *September*, 1878.]

Having recently completed a census of the Molluscan Fauna of Tasmania, it will be probably useful if I add some remarks on the nature of that fauna and its geological relations. The time has hardly come when this can be done completely. Dredging operations have not been carried out to any extent, so that the nature of the laminarian zone is little understood. The Molluscan Fauna of Australia is also only very partially known. New South Wales or the east coast is perhaps the best explored, but still far from completely; and as for South Australia and Victoria, our knowledge is extremely imperfect. It will be seen, therefore, that I can only give broad and very general conclusions, such as I think future discoveries will not materially alter.

In order to understand the fauna of Tasmania we must bear in mind first of all the physical character of the island. It is separated from Australia by a wide and deep strait, 90 miles at least at its narrowest part, though that interval is to some extent bridged over by groups and chains of large islands. It is situated in more temperate latitudes than any part of Australia, and on its southern side it is exposed to the full force of the southern ocean, as well as to the influence of much colder seas. The coast is almost without exception bold, precipitous, and rocky, with many islands. There are numerous inlets and bays running up very far into the land and perfectly sheltered, so that tranquil and shallow waters are by no means wanting. The sea, though not a warm one, appears to be very equal in temperature. It is fed by numerous freshwater streams, and there are many brackish estuaries. In these particulars Tasmania contrasts very strongly with the south coast of Australia. The sea there is warmer, and the coasts are seldom bold. There are immense stretches of sandy beach of nearly 100 miles at a time. There are few rivers, and instead of estuaries there are many shallow arms of the sea or brackish water lakes. The south-east coast of Australia differs to some extent from this, resembling Tasmania more. The shore is often bold and much more broken; there are scarcely any islands, and the seas are exposed to the full influence of the southern ocean.

First of all, it may be necessary to note from what naturalists our knowledge of the Tasmanian Molluscan Fauna is principally derived. The first that ever visited the island were undoubtedly Banks and Solander, in the celebrated expedition of Captain Cook in 1770; yet from these, or any subsequent naturalist up to the time of the voyage of the "Astrolabe," it does not appear that Tasmanian or even Australian conchology received any development. No doubt collections were made, and these stored in the museums of London and Paris, awaited the advent of such men as Lamarck; but, from actual observations during voyages, we find nothing printed until the voyage of the "Astrolabe." The only shell which appears to have been named by Solander is *Cyprea piperita*, *teste* Gray in the *Zoological Journal* (London, 1824, vol. 1, p. 498), and this must have been merely a name given to the specimen in the British Museum, as there is no record of any publication. Linnæus died January 10, 1778, but from the year 1772 he had ceased to take a part in scientific discovery; yet we have no less than eight Tasmanian species with his name as an authority. They are *Triton cutaceus*, *Fasciolaria trapezium*, *Cyprea annulus*, *Philine aperta*, *Teredo navalis*, *Lucina divaricata*, *Ostrea edulis*, and *Lima radula*. The latter I think we may dismiss as doubtful. The shell thus identified is described as an *Ostrea* by Linnæus, which genus according to his views included in its first section *Lima* and *Pecten*, and in the second *Ostrea*, *Malleus*, *Pedum*, &c. The shell described by him was taken from Lister (1685) and Rumphius (1705). He describes it as "Shell nearly equivalve, with twelve convex rays crossed by crenate striæ 3¼ inches long by 2½ broad." He says "it inhabits the Indian Ocean, and is oblong, white or varied with white and brown, lower valve a little more convex, ends wrinkled and furrowed with oblique striæ." The shell is now recognized as a *Pecten*, and is described as such in Lamarck (Anim. S. V., vol. 7, p. 134) and Sowerby (Thes. Conch, pl. 17, fig. 154–5). *Triton cutaceus* is described in Linné's genus *Murex*. If the identification is correct, this is also figured in Lister (Tab. 942). It is said to inhabit Barbary, Guinea, and South America. *Fasciolaria trapezium* is also of Linné's *Murices*, and figured by Lister (Tab. 930, 931) and Rumphius (Mus. tab. 29, E., tab. 49, fig. K). It is said to inhabit the Indian Ocean, and to be often above 6 inches long. Sowerby says it occurs in the West Indies also.* *Cyprea annulus* is figured by Rumphius, but not very successfully. It is said by Linné to inhabit Amboyna and Alexandria, which is not very likely. It is said also to come from the Red Sea, and certainly its appearance is different from any of the Australian Cypreas. I have been assured however that it occurs in Tasmania, where specimens in private collections

* In this case the shells of two such remote places being similar is no proof that the animals are equally alike.

are not at all uncommon. It is much more like a Red Sea shell than of any other locality. It is stated to occur in New Zealand, but Captain Hutton assures me that he has never seen or heard of an instance. It is known on the E. Australian coast. Further inquiries are needed to clear up this rather mysterious case of irregular distribution. *Philine* (*Bulla*) *aperta* is described as a roundish pellucid transversely substriate small shell with one end much produced, and the apertures very open, that is with the lower lip spread out. It inhabits Europe and Africa (*sic in origine*). It is probable that Linné got his description from Gualtieri's work, which appeared at Florence in 1742, and was entitled *Index Testarum Conchy, q. adservantur in Mus. N. Gualtieri Phil. et Med. Florentini.** *Lucina divaricata* is another somewhat doubtful identification. It was figured by Lister, and was described by Linné as a shell with thin transverse longitudinal striæ crossing some divergent ones towards the margin, posterior impression ovate, margin crenate. Inhabits the East Indies. Turton adds that it is white, with brown lines, veins, and spots, anterior slope oblong, gaping, veined blackish brown, with 4 hinge teeth. (See *Turton's Linnæus*—A General System of Nature. London: 1806. Vol. 4, p. 226†.) No doubt many other identifications might be made if the figures in some of the earlier works were a little better, or had the types been preserved. But such an inquiry would be barren of any results, except to rake up new synonyms, of which we have quite enough already. Besides, the identifications that we have so far are by no means satisfactory, and what is admitted by one as a description or a figure of a known species is denied by another; and thus considerable confusion results. For my part, it does seem a useless waste of time, space, and printing to burden our scientific books with synonyms of a pre-Linnean history. They are doubtful at the best, and can serve no useful purpose whatever.

Every one of the eight species above enumerated are of wide distribution, and, almost certainly, the specimens from which the descriptions were made came from the West Indies, the Red Sea, the Indian Ocean, or the Mediterranean. Thus, *Ostrea edulis* was the common European form. No difference can be detected between our species and that of Linné. It may well be questioned if it be not introduced in Tasmania at least. In Australia the case is different, for it is more abundant, and is found as a Pliocene fossil. *Teredo navalis* is most certainly

* This work is especially interesting as containing a conchological system composed by Tournefort.

† As Turton translates Gmelin and adds a few (very few, and often incorrect) remarks of his own, I am uncertain whether the observations are his or by the continuator of Linné.

introduced and was known to Linné only from European forms. It has been brought in timber from Europe, and a more unwelcome case of acclimatization we can hardly imagine.

After Linné we have very few names or descriptions anterior to those of Lamarck, who published the first edition of his *Histoire Naturelle des Animaux sans Vertèbres* in 1815–23. During the period intervening between Lamarck and the discoveries of Capt. Cook in 1770, we have only the following names:—*Argonauta oryzata*, Meuschen; *Triton spengleri*, Dillwyn. Both these were not from Australian specimens, as the species have a wide range. *Heliotis nævosa*, Martyn; *Purpura succincta*, Martyn; *Risella melanostoma* (*or Trochus*), Gmelin; *Phasianella tritonis*, Chemnitz; *Trochocochlea Australis*, Favanne; *Patella tromoserica*, Martyn; *Patella radians*, Gmelin; *Cyprea angustata*, Gmelin; *C. comptoni*, Gmelin;* *Turbo undulatus*, Chemnitz; *Turbo stramineus*, Martyn.

Before I make any observations on these, it may be necessary to say something about the authors and the various works where their descriptions are to be found.

The dawn of a true science of conchology may be said to date from the books of our countryman, Lister, who in 1685 commenced the publication of his great work entitled, *Historia sive Synopsis Methodica Conchyliorum*. It was in four books: 1, of land univalves; 2, of freshwater univalves and bivalves; 3, of marine bivalves and Balanidæ (*Conchis anatiferis*); 4, of marine Patellæ, Dentaliums and Buccinums. I have translated the title of the divisions of this really marvellous work—marvellous for the age, whether one regards the genius of the author or the accuracy of the figures. These were 1,057 in number; but, the plates being bequeathed to the University of Oxford, another edition of them was published in 1770, where the figures of shells alone (exclusive of fossils) amount to 1,153—all executed with rare industry by Dr. Lister's daughters, Sussanah and Anne Lister. I gladly avail myself of the opportunity of helping to make known their names. The remains of Dr. Lister's Museum are still to be seen in the Ashmolean Museum at Oxford. Without mentioning any of the subsequent writers on the subject—as they may scarcely be said to have advanced it at all—we may just refer to the work of D'Argenville, a French writer, who in his work, *L'Histoire Naturelle éclaircie dans deux de ses Parties principales, les Lithologie et la Conchyhologie*, Montpellier, 1742, laid the foundation of a system which Linné subsequently adopted. His genera include—*Patella*, *Haliotis*, *Dentalium*, *Nerita*, *Helix*, *Trochus*, *Strombus*, *Nautilus*, *Conus*, *Cyprea*, *Ostrea*, *Venus*, *Chama*, *Pholas*, *Solen*. These genera correspond very nearly with those of

* On the testimony of Dr. J. E. Gray.

Linné, under the same name. The figures were excellent, and earned for the author from Linné the title of "nitidissimus," *i.e.*, neatest or most exact.*

The advent of the great systematist Charles von Linné † began a new era for conchology. The first edition of his *Systema*, published in 1735, was little more than a small prospectus of fourteen folio pages, but which was sufficiently important to attract universal attention. His efforts in the matter of shells was less happy than other portions. The great aim of the author was simplicity, and this feature was decidedly destroyed by his genera being too few. Confusion, not simplicity, was the result. His original genera were only eight in number—viz., *Cochlea*, *Cyprea*, *Haliotis*, *Patella*, *Nautilus*, *Lepas*, *Concha*, and *Dentalium*. Two or three more genera were added; but it was not until the tenth edition (1753) that he augmented the number to thirty-two, which was subsequently increased to thirty-five, and the most of them we have seen were taken from D'Argenville. The genius of Linné was seen in the way in which he seized upon salient specific characters, and rejected the weak, shifting, and multitudinous features of preceding naturalists, which impeded science, as they were too numerous, non-permanent, and confusing. Still Linné never rose to a true perception of the nature of the animals with which he had to deal. The shells were all Testacea, and the animals which dwelt in them Vermes or worms, distinguished from one another by very arbitrary features. It was left to Cuvier to perceive the true relations of the animals, and to build the science on a solid and permanent basis. It must not be imagined, however, that this was all Linné ever did on conchology. His *Fauna Suecica* (1st ed. 1746, 2nd ed. 1761), his *Museum Tessinianum*, *Museum Adolphi Fred. Regis*, and *Museum Ludovicæ Ulricæ Reginæ*, all contributed to extend his system, and doubtless to enlarge his own knowledge of the subject. In the last-named work he describes 434 species of shells. Strangely enough, however, though the volume is published in 1764—that is after the tenth edition of his *Systema*—it preserves his old divisions of *Conchæ* and *Cochleæ*. His *Mantissa altera* (another addition) embraces the description of thirty-five new species.

From Linné to Lamarck is nearly half a century, that is from the date of their systems; yet we have only very few pre-

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* Swainson, however, says that the plates are inferior, and whatever was good in the work was taken from Lister. See "Shells and Shellfish," p. 14.

† The Swedish form of this name—*i.e.*, Linnæus—is the one most in use. When knighted he was better known as Charles von Linné. It is said that the termination in "us" denotes a plebeian origin, and that when in 1757 he was admitted amongst the hereditar nobility he was called C. von Linné.

Lamarckian names amongst the shells of Tasmania. This is more astonishing if we remember the numbers of different expeditions to Australia, &c., in the last twenty years of the 18th century. There was the French expedition under Captain Marion, in 1772, in the ships "Mascarin" and "Castres"; Furneaux in 1773; Cook in 1777; and the settlement at Port Jackson in 1788, from which a perfect stream of specimens of natural history must have flowed into Europe. There was Vancouver in King George's Sound in 1791, Cox in Tasmania in 1789, Bligh also in 1792, and D'Entrecasteaux, with Labillardière as naturalist, in the same year. Then came Flinders, Bass, Grant, and the French expedition under Baudin with the naturalists Peron and Freycinet. No doubt the latter contributed largely towards Lamarck's work; but until then, from the time of Linné, we have only the names already given: *Argonauta oryzata* and *Triton spengleri* may both have come from the Indian Ocean. Meuschen, who is the authority for the first, is only known for two catalogues of celebrated collections, viz.:—1. Of Laurence G. Gronow* a senator of Leyden (published in 1781), and the collection of Abraham Gevers of Rotterdam. It is in the catalogue of the second (p. 252, n. 133) that the *Argonauta* is described. As most of these Dutch collections were made in the trade to the Indian Ocean and Spice Islands, we can generally guess to what locality to attribute any specimen. Dillwynn's species was described in "*A Descriptive Catalogue of Recent Shells, arranged according to the Linnean method with particular attention to the synonyms.* 2 vols. 8vo. London, 1817." *Purpura succincta* is from Thomas Martyn's† *Universal Conchologist*, which is described by the author as "exhibiting the figure of every known shell accurately drawn and painted after nature, with a new systematic arrangement and explanatory tables in English and French; also figures of nondescript shells collected in different voyages to the South Seas since the year 1764, with seventy-seven coloured drawings of shells. London, 1789. 1 vol. 4to." I have had a copy of this very rare work sent to me from London for inspection. It is extremely costly, and was only the first volume of a work which was never finished. The author also published "Drawings of Shells of the South Sea. 1 vol. 4to., fifty-eight plates." The whole work is an *édition de luxe*, and cannot be too highly praised for accuracy as far as it goes. The

* This work of Meuschen's must not be confounded with the catalogue previously published by Gronow himself, entitled *Zoophylacium Gronovianum*. It came out in 3 parts, viz.:—Fasc. 1, 1763; Fasc. 2, 1764; Fasc. 3, 1781. There are twenty copper plates of figures and descriptions of 589 species. The method is Linnean.

† This author must not be confounded with W. F. Martyn, who wrote a "New Dictionary of Natural History," 2 vols. folio, coloured plates (many shells). London, 1785."

author was a systematist, but not of much genius. He gave tables of the Linnean method as well with many valuable observations on conchological writers. Gmelin was the continuator of Linné, and published a 13th edition of the Systema Naturæ, in 3 vols.; Leipsic, 1788-93. He is said to have raised the number of species of shells to 2,334. Messrs. Maton and Rackett,* however, do not give him much credit for either accuracy or genius, or to his translator Turton. The names of Martini and Chemnitz occur pretty constantly in every conchological work of modern times. Both authors were engaged upon one work which is entitled "*Neues Systematishes Conchylien-Cabinet.*" It was begun by F. H. W. Martini, who published the 1st volume in 1769, 2nd volume 1773, the 3rd 1774. The work would have been left unfinished but for a Danish clergyman named J. H. Chemnitz, who published the 8 concluding vols. as follows: 4th, 1780; 5th, 1781; 6th, 1782; 7th, 1784; 8th, 1785; 9th, 1786; 10th, 1788; 11th, 1795. An alphabetical index of specific names was added by J. S. Schrötter, in 1788, to the first 10 vols. All were published at Nuremberg. There were over 4,000 coloured figures, and in the latter volumes very many species from the South Seas. It is one of the most valuable of the old works, though some of the figures are barely recognizable. Its greatest value was from the new materials which it made use of from various cabinets, more particularly that of Spengler, who had one of the finest collections then known.

In the year 1797, George Humphrey, F.L.S., the chief dealer in shells then living, published a small pamphlet entitled, "*Museum Calonnianum*—Specification of the various articles which compose the magnificent Museum of Natural History collected by M. de Calonne in France. London, May 1, 1797." It was published anonymously. I mention this work, as it is much mixed up with the question of nomenclature. Some naturalists have claimed for it a merit to which it is scarcely entitled, and would even make the genera of Lamarck give way to it. The latter published his work, *Vers Testacés, Tableau Encyclopédique et Méthodique*, Paris, 1797-98, 390 Plates, a year later, but Humphrey's work is in every way inferior. It is a mere list without any definitions, its principal merit being in the indication of several good genera. We may be sure, however, that through Mr. Humphrey a large number of Tasmania shells became known to the world.† His son was one of the very early colonists. Had

* "A Historical Account of Testaceological Writers." Linnean Transactions, vol. 7, 1804. I have found this essay of great use to me, though some of the omissions are remarkable, and the details at times scanty.

† Mr. Swainson, in his "Shells and Shell-fish," goes so far as to say that Brugiere and probably Lamarck and Cuvier, borrowed from Humphrey without acknowledgment.

the pursuit of shell-collecting any really scientific pretensions at that time we should have had little to glean; but size and colour were more regarded then, so that the smaller shells or the unattractive shells were left for the scientific gleaners.

In the list I have given of the shells with pre-Lamarckian names there are none which may not have come from Australia, as they are equally common there, and two, as we have seen, extend to the Indian Ocean. One, *Patella radians*, Gmelin, cannot be made out at all, unless I am right in supposing that it is one of the many varieties of Quoy's *Acmæa septiformis*. (*Patelloidea s.* in his work.)

Having stated what I think important in reference to those books in which the older names of Tasmanian shells are to be found, I proceed to give a list of all the books in which any part of the same fauna is described. I have marked with an asterisk those works which I have not been able to consult, and shall merely name the works already referred to, marking them thus †.

First enumerating the serials, we have :—

1. Proceedings of the Zoological Society of London—generally. The earlier numbers containing the monographs of Hinds, Reeve, Adams, and the later (from 1865) the lists of Australian fauna of Angas.
2. Annals of Natural History generally.
3. Proceedings of the Linnæan Society of London—the earlier transactions.
4. The Zoological Journal. 5 vols., 8vo., with supplementary coloured plates. London, 1825-35.
5. Proceedings of the Royal Society of N. S. Wales from 1866.
6. Proceedings of the Royal Society of Victoria from 1857.
7. Proceedings of the Royal Socety of Tasmania, years 1854-55, contain valuable papers by W. Swainson. Years 1875-76-77-78, papers on conchology from myself and various authors.
8. Proceedings of Boston Natural History Society, containining all Dr. A. A. Gould's papers, descriptions of Australian shells in nearly every volume.
9. Journal de Conchylioligie, from 1860 to date, containing all the diagnoses of Crosse and Fischer's new Australian shells, and numerous monographs and lists of our fauna.
10. British Museum Catalogues. All the conchological ones contain Australian materials, notably the elaborate diagnoses of Deshayes.

11†. LINNE. The tenth edition is the first which contains any details about conchology. The other works have been referred to already.

12†. MARTINI and CHEMNITZ, *ut sup.*

13†. MARTYN'S UNIVERSAL CONCHOLOGY, &c.

14†. HUMPHREY. MUSEUM COLON., *ut supra.* I have only seen Swainson's reproduction of his system.

15*†. MEUSCHEN, *ut supra.*

16*†. DILLWYNN'S CATALOGUE.

17. THE MALACOLOGICAL AND CONCHOLOGICAL MAGAZINE. By G. B. Sowerby, Parts I & II, London, 1838-9.

18. SPECIES CONCHYLIORUM, or concise original descriptions and observations of all the species of recent shells, with their varieties. Part I containing a monograph of the genus *Cymba,* by W. J. Broderip, and monographs of the genera *Ancillaria*, *Ovulum,* and *Pandora,* by G. B. Sowerby. 4to, 14 col. plates. London, 1830.

19*. A catalogue of the shells contained in the collection of the late Earl of Tankerville, arranged according to the Lamarckian Conchological System; with an appendix containing the descriptions of many new species. Small 4to. 9 col. plates. London, 1825. By G. B. Sowerby.

20. THESAURUS CONCHYLIORUM, or figures and descriptions of shells. By G. B. Sowerby, jun., London. Begun in 1842, and continued for some years. I have only seen three volumes, and believe that the work was not continued.

21. A CONCHOLOGICAL MANUAL. By G. B. Sowerby, jun., 8vo., second edition, 662 figures (only 500 in the first edition). London, 1842.

22. CONCHOLOGICAL ILLUSTRATIONS, or coloured figures of all the hitherto unfigured recent shells. Containing monographs of *Cardium, Chiton, Bulimus, Murex, Cancellaria, Conus, Neritina, Fissurella, Eulima,* &c. 2 vols., 12mo., 158 coloured plates. London, 1832-41. The figures excellent, but the letter-press very bad, and the arrangement confused.

23. THE GENERA OF RECENT AND FOSSIL SHELLS. 2 vols. 8vo., 266 col. plates. By James Sowerby. London, 1820-24.

24. SWAINSON'S TREATISE ON SHELLS AND SHELL-FISH. London, Longmans, 1840. 12mo. Woodcuts only, but good figures. A rather fanciful work, but some of the genera have been adopted, and full justice has hardly been done to it. It is one of Lardner's Cabinet Cyclopædia.

25. EXOTIC CONCHOLOGY, or drawings of rare, beautiful, or undescribed shells. 4to., 48 col. plates. London, 1834. By W. Swainson. Contains only one or two Australian species.

26*. APPENDIX TO THE CATALOGUE OF THE BLIGH COLLECTION. By W. Swainson. I have not seen this work; my knowledge of it is derived from the reference in the Exotic Conchology.

27. ZOOLOGICAL ILLUSTRATIONS, or Original figures and descriptions of new, rare, or otherwise interesting animals. By W. Swanison. 3 vols., 8vo; 182 col. plates of birds, insects, and shells. London, 1832-33.

28. CATALOGUE OF MARINE MOLLUSCA, &c., OF NEW ZEALAND. By Capt. F. Wollaston Hutton, N.Z., 1869.

29. CRITICAL LIST OF MARINE MOLLUSCA OF NEW ZEALAND. By Dr. E. von Martins, N.Z., 1872.

30. Addenda and Corrections to same. 1877.

31. *BORN (Ignatius, Baron) TESTACEA MUSEI VINDOBONENSIS. (A Catalogue of the shells preserved in the Museum of the Empress of Austria at Vienna.) 1 vol., fol. Vienna, 1780. It is printed in German and Latin. The method is Linnean, descriptions terse and correct, with a copious list of synonyms which is very valuable. There are 616 species described, with indexes to the German, Dutch, French, and English names. Two years after the publication of the descriptive letterpress, which forms a thick volume, the plates appeared, 18 in number, with above 200 figures, in a splendid folio. I am not aware that there is a copy in any of the Australian Colonies.

32. CONCHOLOGICA SYSTEMATICA, or a complete system of conchology. By Lovell Reeve. 2 vols., 4to, col., 1,500 figures. London, 1842.

33. ELEMENTS OF CONCHOLOGY, an introduction to the Nat. Hist. of Shells and of the animals which form them. By Lovell Reeve. 2 vols., large 8vo., with 174 col. plates, containing 370 figures. London, 1860. The system is Lamarck's nearly. There is a useful list of all the species.

34. CONCHOLOGICA ICONICA. A complete repertory of species, pictorial and descriptive, 4to. London. By Lovell Reeve. This work was begun in 1842, and is continued to the present day. It forms perhaps the most accessible general work we have, and therefore the most valuable. It must be admitted, however, that the diagnoses are faulty and brief, and the habitats can

seldom be relied upon—Tasmania, Australia, and New Zealand are confounded; but in this respect most European writers are not particular. The figures are generally very good. But since Australian and Tasmanian conchology have made their greatest advances subsequent to the earlier monographs, the work will be necessarily very incomplete for the Australian provinces unless a supplement should be published.

35. ICONOGRAPHIE DES COQUILLES VIVANTES. Par L. C. Kiener. Paris. 4to. A series begun in 1834, and very similar to Reeve's. I have only seen one or two parts, but in those the figures, &c., seemed to me superior to the English work.

36. DIE SUDAFRIKANISCHEN MOLLUSKEN. 4to., 6 coloured plates. Stuttgart, 1848. By Prof. Ferd. Krauss. Though this work professes to deal only with S. African shells, a good many Australian and Tasmanian species are described amongst them. Dr. E. von Martins states that in the collections sent to the Museum by Baron von Ludwig there were a good many Australian shells, and that Krauss was not aware of this.

37. VOYAGE OF H.M.S. "SULPHUR." Zoology. 4to. Lond., 1839. Mollusca by S. Hinds. A very few Australian species in this work, but it may be consulted for the tropical fauna.

38. VOYAGE DE LA CORVETTE "L'ASTROLABE" sous le commandement de M. Dumont d'Urville. Paris, 1835. Zoologie, par Quoy and Garmard. 4 vols., 8vo. Atlas with coloured plates. This work is one of the most valuable we have for Australian species. The figures are good, and the drawings of the animals, anatomy, &c., very full and detailed.

39. VOYAGE OF H.M.S. "SAMARANG." Zoology. 4to, coloured plates. London, 1848. Mollusca by Arthur Adams, R.N. Useful for our tropical fauna. The drawings of the animals are most useful.

40. VOYAGE OF H. M. S. "RATTLESNAKE." 2 vols. 8vo. London, 1852. Appendix on the Mollusca by Prof. Forbes. A very few tropical Australian species described.

41. KING'S VOYAGES IN AUSTRALIA. London, 1827. The appendix on the Mollusca, by J. E. Gray, of the British Museum, is very full, and contains many descriptions of new species, which, however, are rather too brief. It must be consulted in all questions of nomenclature.

42. DIEFFENBACH'S NEW ZEALAND. 2 vols., 8vo. London, 1843. The appendix to this work is also by Gray, and contains very many new species.

43. YATE'S NEW ZEALAND. Appendix by Gray, with many new species. In this and the preceding work the diagnoses are far too brief. 1 vol. 8vo. London, 1835.

44.† LAMARCK, *ut supra.*

45. MENKE MOLLUSCORUM NOVÆ HOLLANDIÆ SPECIMEN. Hanover, 1843. 4to. A very thin tract in Latin which contains full diagnoses of a large number of Australian species, the most of which, however, were from the south-western part of the continent. A few Tasmanians are to be found amongst them. The work is very rare; I have never seen but two copies in Australia. There are none in any of our public libraries. It would be a very small expense, but a great boon to reprint it.

46. WOOD'S GENERAL CONCHOLOGY. London, 1815, with 59 coloured plates, 8vo.

47. WOOD'S INDEX TESTACEOLOGICUS, or a catalogue of shells, British and foreign, arranged according to the Linnean system. 8vo., 2nd edition, 2,300 coloured figures. London, 1828. Supplement with 480 coloured figures. This work, though the figures are all of one size and small, yet are tolerably executed. The arrangement is very confusing; but still, I may safely say it is indispensable to any person collecting, and is a very convenient handbook of species.

48. GENERA OF MOLLUSCA, by A. & H. Adams. 3 vols., small 8vo., with 138 plates. London, 1858. This is certainly one of the most valuable books on the subject; but, according to the opinion of many, much marred by the revival of many useless genera, and by the substitution on the most slender claims, of the forgotten names of Humphrey, Bolten, Montague, &c., for the well-known ones of Lamarck. I shall refer to this subject again in this essay.

49. WOODWARD'S MANUAL OF THE MOLLUSCA, being a treatise on Recent and Fossil Shells. 3rd edition, with an appendix of recent and fossil conchological discoveries, by Ralph Tate, pp. xiv, 542, 86; 23 plates and many woodcuts, 8vo. London. The appendix treats of those recent and fossil shells not mentioned in edition 2. It contains, therefore, descriptions of all the genera founded since 1866. It is separately paged, and illustrated by 27 woodcuts. No commendation is needed for this most excellent manual. There is no other book

in any language like it for cheapness and high scientific character. It has done more to popularize conchology than any other book in the range of the subject. Professor Tate's additions are very valuable.

50. MANUEL DE CONCHYLIOLOGIE et de Paléontologie conchyliologique, par le Dr. J. E. Chenu. 2 vols., large 8vo. Paris, 1859. This work is illustrated by very nearly 5,000 exquisite wood engravings. It is much more costly than Woodward, but then its range is much wider. A very large number of Australian species are figured. With its aid one ought to be able to arrange and name the most of the species in any collection.

51. A MONOGRAPH OF AUSTRALIAN LAND SHELLS, by James C. Cox, M.D., 8vo., Sydney, 1868, with 18 coloured plates, containing over 400 figures. This work, I need hardly say, is perfect of its kind, and reflects the highest credit upon the author. It is truly an astonishing production for a young Colony.

52. COX'S EXCHANGE LIST OF AUSTRALIAN SHELLS, Sydney. Names only. Dr. Cox very properly did not undertake the question of synonomy or genera, but merely gave a list of such species as he had recognized.

53. A MONOGRAPH OF THE LAND SHELLS OF TASMANIA, 1 vol., 8vo., Tasmania, 1873. By W. Legrand. A smaller work than that of Dr. Cox, but nearly equal to it in finish and completeness.

54.* FAVANNE DE MONTERVILLE, père et fils. 3 vols., 4to., Paris, 1780. This is an augmentation of D'Argenville, *vide supra.*

55.* KOCH in Abbildungen und Beschreibungen neuer oder wenig gekannter Conchylien. 3 vols., 4to., col. plates. R. A. Philippi. Cassel, 1842–50.

56. PFEIFFER MONOGRAPHIA HELICORUM VIVENTIUM. 2 vols., 8vo. Leipzig, 1848.

57. JONAS Zeitschrift, für. Malac., &c. The German Journal of Conchology, in which many Australian species are described.

58. C. F. SCHUMACHER. Essai d'un nouveau système des habitations des vers testacés. Copenhagen, 1817. 4to., plates. I only know of one copy of this scarce work in these Colonies, which is in the library of the Royal Society of Tasmania.

59.* H. C. KUSTER. This is a new edition of Martini and Chemnitz, published in Nuremberg from 1837, and for many years subsequently. Many new Australian shells are described.

60. DESHAYES HISTORIE NAT. des animaux sans vertèbres. This is a second edition of Lamarck from 1835–45, in 11 vols., 8vo. In this edition Milne Edwards also assisted. A good many† of the Tasmanian shells are described in it, but the diagnoses are very brief.
61. DESHAYES TRAITE ELEMENTAIRE DE CONCHYLIOLOGIE. 8vo., 8 pl. Paris, 1838.
62. THE YOUNG CONCHOLOGIST'S BOOK OF SPECIES. Univalves. 12mo., with figures. London, 1840. By Silvanus Hanley.
63. An illustrated and descriptive CATALOGUE of recent shells. By SILVANUS HANLEY. 8vo. London, 1844.
64. COOPER in Magazine of British Zoology, vol. 2.
65. BLAINVILLE in Bulleten des Sciences Naturelles. Feb., 1817.
66. BLAINVILLE. MANUEL DE MALACOLOGIE et de Conchyliologie. 2 vols., 8vo., 87 plates. Paris, 1836–7.
67. ED. DONOVAN. THE NATURALIST'S REPOSITORY, vol. 3, p. 78. (The whole work is in 5 vols., 1824–27.)
68.* SPENGLER Schrift. Nat. Ges. Z. V. Copenhagen, 1790.
69. D'ORBIGNY-ALCIDE. Voyage dans l'Amérique Méridionale, dans 1826–33. Mollusques Foraminifera et Géologie. Paris, 4to., 1834–44.
70. A. Adams and Angas refer to the Zool. of Beechey's Voy. of the "Beagle" for a description by Sowerby of *Patella costata* = *Acmæa costata Angas.* I have not been able to find any such name.
71. JAY'S CATALOGUE OF SHELLS, 4to. New York, 1852. This contains a very extensive list of Australian and New Zealand species. There is also a bibliography, though not extensive, in the library catalogue of the author at the end of the work.

I have not arranged these works chronologically, because I have kept the works by the same authors together. I have only enumerated those authors or those works where the original figures or descriptions, or both, of species inhabiting Tasmania are to be found, or else of works which will give the greatest help in the classification of the Tasmanian fauna.

It remains to state that until the date of the census published in last year's Proceedings of the Royal Society of Tasmania, nothing whatever was done towards a classification of the mollusca of those seas. Indeed it has only been lately that anything has been done towards making a census of the mollusca of any part of Australia. The first step was by Mr. Angas, who, in 1865, published a very complete list of the shells of South

Australia. This appeared in the Proceedings of the Zoological Society, and was accompanied and followed by the description of very many new species. In 1867 a similar list was made in the same periodical for the mollusca of New South Wales. This, however, was more than a list, for it had descriptions or a short diagnosis of each species dealt with. Ever since that time Mr. Angas has been making additions to the list by publishing new species, and we may say that no naturalist has so persistently laboured to classify Australian shells, or done more for our molluscan fauna. Next to him Dr. Cox and Mr. J. Brazier. The latter, in his painstaking enumeration of the mollusca of the Chevert Expedition, has done much to simplify the labours of all future observers.

I now proceed to enumerate from the works of the naturalists named above what shells Tasmania really possesses; for the mistakes of habitats found in most European writers are really innumerable. I find the following shells mentioned as occurring in Tasmania which I have not been able to trace. *Ancillaria mucronata*, Sowerby; *Terebra Kieneri*, Deshayes; *T. nitida*, Hinds; * *Conus pontificalis*, Lamarck; *Littorina philippi*, Carpenter; *Clanculus nodulosus*, A. Adams; *Cerithium serotina*, A. Adams; *Zizyphinus granulatus*, Born; *Patella costata*, (?) *Patella radians*, Gmelin; *Chiton: C. piceus*, Gmelin; *C. proteus*, Reeve; *C. glaucus*, Gray; *C. Sinclairi*, Gray; *Corbula zelandicus*, Gray; *Anapa triquetrum*, Hanley; *Tellina diemanensis*, Deshayes; *T. tristis*, Deshayes; *Gari compta*, Deshayes; *Hiatula vitrea*, Deshayes; *Semele exigua*, H. Adams; *Callista planetella*, Lamarck; *C. candida*, Deshayes; *C. rutila*, Desh.; *C. citrina*, Lamarck; *Dosinia coryne*, A. Adams; *D. crocea*, Deshayes; *Rupellaria brevis*, Quoy; *Mytilus Dunkeri*, Reeve. To this may be added *Patella limbata*, which Phil states came from N. Australia, but which has been identified with *P. tramoserica* Chemnitz; but whether rightly or no we have no authentic specimens to determine. Some of these shells are distinctly stated to have come from Tasmania by the authors, and others are referred to as coming from places which can only be doubtfully identified with Tasmania.

It is curious however to observe the converse of this list, that is, of shells which are attributed to other countries which belong only to Tasmania. A list has lately been published in the *Journal de Conchyliologie* (1878, p. 1), by Capt. F. W. Hutton, of the shells known to occur in New Zealand and the Chatham Islands. In this list is given the names of shells attributed to New Zealand, but which the author had been unable to find there. Amongst those the following are found in Tasmania—*Thalotia conica*, Gray; *Siphonaria diemanensis*, Quoy; *Mytilus*

* This is a West Australian shell.

hirsutus, Lamarck; *Venus* (*Chione*) *lamellata*, *Cardita amabilis*, Deshayes' Lamarck; *Cominella lactea*, Reeve; *Haliotis albicans*, Sw.; *Littornia vilis*, Reeve (which is a young and dwarfed species of *L. pyramidalis*, Quoy); *Kraussia lamarckiania*, Davidson.

On the other hand, some of the missing shells of the former list are chronicled as occurring in New Zealand, which is the true habitat of the following—*Chiton sinclari*, *Chiton glaucus* *Corbula zelandica*, *Mytilus dunkeri*.

I must now refer to another matter, that is, the names of the genera. Mr. G. F. Angas, in his list, has followed the generic names of Messrs. Adams in his critical list, a plan which I have not adopted. My reasons for this are best found in the words of M. Chenu, whose opinion I shall quote in the extract which follows—"Lamarck is the true founder of conchology as a science, and his generic names, which were always judiciously chosen, have been universally adopted. They belong to science, and consecrated by use ought to be preserved, if we do not desire to throw into confusion a science which is already complicated enough, and which the necessary creation of new genera is complicating still more. Let us leave to Lamarck the credit which no one can deny him, and do not let us uselessly re-baptize his families and his genera for the sake of ascending to equivocal and trifling genealogies, which are not in most cases improvements. The principle of priority is a good one, but it is not advisable to apply it too strictly in such cases, and above all in the names of genera. Most of the authors whose generic names are thus revived knew but a small number of species, and their observations were too limited for the names they employed to have any other importance than their historic interest. The collections with which Linné had to deal were not proportionate to the power of his genius, and we cannot suppose that he would have misunderstood the differences which did not escape Lamarck, whose opportunities for observation were more than double, and which have led him to divide the great genera proposed by that prince of science. It was thus that Lamarck, more favoured than Linné, was able to lay the foundations of conchology, and as it were incorporate the science, but at the same time giving us an example by respecting the names given by his predecessors when they had come into general use. For instance, if he divided a genus of the Swedish naturalist into many others, he kept the name given by his illustrious predecessor for the principal one. We have always thought that everything should be avoided which tends to render the access to science difficult, and all that would discourage the first steps. But we regret to see that Messrs. Adams, in order to submit themselves to the principle of priority, have adopted names generally ignored or completely forgotten, for genera

which all conchologists know perfectly well by names long consecrated by use. We will give some instances to prove that certain names which have no motive whatever for their adoption, cannot be preferred at the present day to names given since or about the same epoch by a man of science, whose book is still the most sure and most generally adopted guide. Who is the collector of the present day who would go back willingly to the names given formerly by Bolten, Klein, Gronovius, Humphrey, Link, and Denys de Montfort, to genera which often did not exist, or whose characters, relations, and limits Lamarck was the first to establish? If we place side by side of the names employed by Lamarck the old names whose revival we condemn, the question will be decided at once. Thus—*Architectonica*, Bolten = *Solarium*, Lamarck. *Bursa*, B. = *Ranella*, L. *Angavia*, B. = *Delphinula*, L. *Harpago*, Klein = *Pterocera*, L. *Actinobolus*, K. = *Cardita*, L. *Pentadactylus*, K. = *Ricinula*, L. *Dactylus*, K. = *Oliva*, L. *Gladius*, K. = *Rostellaria*, L. *Amphiperas*, Gronovius = *Ovula*, L. *Eutropia*, Humphrey = *Phasianella*, L. *Isognomum*, K. = *Perna*. L. *Umbonium*, Link = *Rostella*, L." After stating his appreciation and admiration of the labours of Messrs. Adams, whose divisions he follows where possible, as well as those of Albers, Pfeiffer, and partly Gray, and after making every allowance for fossil genera, M. Chenu states that he preserves all the names of genera hitherto received, and he expressss a hope which I am sure has been generally reciprocated, except by a very few conchologists in England, that a stand will be made for the defence and preservation of the old names. Otherwise, he says, we must begin to forget the scientific language we have learned, and which is not such a simple thing, but with which we are now familiar for more than half a century, to acquire a new language which offers us no advantage whatever."*

I am sure there are few who will not be convinced by this most reasonable appeal. What have we to gain by the new names? They are not better and they are of doubtful import, for many of them have not been defined. But if we do adopt them will all European conchologists adopt them? Certainly not. And if they did would the geologists do so? I think not. In any case the whole science of paleontology would have to be learned again, and all the books hitherto printed on the fossils would be useless, and only tending to confuse or mislead those who relied on them for scientific names. Besides, paleontologists cannot adopt those sub-divisions which rest on the animal alone; they can never study that part of the subject, except indirectly.

* See Preface to Manuel de Conchyliologie.

For these reasons, therefore, I have declined to follow the example of Mr. G. F. Angas, whose labours in other respects have been such a wonderful help to conchology in Australia. I cannot consent to call the well-known *Phasianella* by the name of Eutropia, *Ranella* by the name of Bursa, *Modiola* by the name of Perna. The latter is a good instance of the confusion which would result, for *Perna* is a most important name in geology, and means quite a different shell. Neither will I call *Pectunculus* Axinia, but I need not extend the list, which will, I hope, speak for itself.

It must not be imagined, however, that on this account all the names are to be rejected which have been introduced by the necessity of creating new genera. But I have not adopted all the new genera. Some of them appear to me to be erected on slight and insufficient grounds. Yet it was not so much on that account that I have not adopted them, because my experience is not wide enough to pronounce on systems which far more learned, and more experienced and industrious men have erected after such care and labour. But I have been doubtful of their application to Australian shells, and in cases where the genera were wholly Australian I may perhaps safely estimate their value, but upon what grounds I have always given and will always give scientific men an opportunity to judge.

In the census published by me I did not attempt to mention families, except in rare and undisputed instances. With regard to this part of the subject we may well say "*adhuc sub judice lis est.*" From the time of Linnæus to our own day systems have followed one another in increasing rapidity. To mention only a few of the leading ones: Lamarck, Cuvier, Blainville, Ferussac, Latreille, Deshayes, D'Orbigny, Savigny, Sander Rang, Milne Edwards, Schumacher, Hartmann, Muhlfeldt, Philippi, Pfeiffer, and Albers, on the Continent, and Humphrey, Fleming, J. E. Gray, Swainson, Adams, and Gwynn Jeffreys, in Britain, have not succeeded in establishing a system which all accept. Still there has been progress. Even some of Lamarck's divisions are still preserved. In the beginning all were too artificial, and now the aim at a perfectly natural arrangement prevents anything short of a perfect system being stationary. It would have been well if some had known where to stop in this matter. As far back as 1822 an eminent Scotch conchologist, Dr. Fleming, in his very able "Philosophy of Zoology" uttered a warning note which would be well worth our while to listen to now. He says in his preface: "There is now much declamation about the worthlessness of artificial systems and the excellence of natural methods. But this excellence is more apparent than real. Many of those natural groups which are so much praised are ill-defined, and it is even acknowledged by their admirers that precise limits must

not be assigned to them. Hence it frequently happens that the definition of a group is applicable to a few genera only, which are considered as its type, and does not embrace other genera which are regarded as belonging to it but beginning to assume the characters of some of the other neighbouring groups. There is here the use of a method where there is no precision, and a boasting that the plan of nature is followed when that plan is confessedly incomprehensible. Indeed it often happens that the admired natural method of one differs from the censured artificial method of another merely in the circumstance that different systems of organs have been made choice of as the basis of the respective classifications. Unless zoologists in the formation of their primary groups endeavour to determine those characters which all the members possess in common, admitting only such marks into the definition, and practise the same method with all the subordinate divisions, the progress of the science will be unsteady; the student will be startled at its contradictions, and the revolutions in nomenclature be as frequent as the cultivators of the science are numerous."

I now proceed to give a brief view of the Molluscan subkingdom as it affects Tasmania.

Class, Cephalopoda.

Argonauta; Spirula, Sepia, &c. I do not enter into detail in this matter, as absolutely next to nothing has been done towards their classification in Tasmania.

Class, Gasteropoda; Sub-class, Proso-branchiata; Sub-order, Proboscidifera; Family, Muricidæ.

Shell thick, with numerous scaly spiniform projections, and more or less salient varices or spines; *operculum* oval, oblong; nucleus apical. Murex 3, Typhis 1, Trophon 9, Fusus 6, Siphonalia 5.

2nd Family, Pleurotomidæ.

Animal, with a posterior slit in the mantle corresponding to a sinus in the shell, and a straight siphon. *Shell* turriculate, with a canal; *operculum* horny; odontophore, two lateral series of teeth only. Pleurotoma 1, Drillia 7, Clathurella 2, Mangelia 9, Daphnella 2.

Family, Tritonidæ.

Animal: Head large; foot short, thick, truncated in front; *odontophore* 7, only 3-1-3; *operculum* horny, oval, oblong; nucleus subapical. *Shell* ridged, with irregular varices. Triton 5, Tritonidea 1, Ranella (varices regular) 3, Pisania 1.

Family, Buccinidæ.

Animal: Head flat, large, two conical tentacles, with ocular tubercles at base; *operculum* horny, small, dentate at the edge; *odontophore*, three lingual teeth in the series, one central and two lateral. *Shell* oval, oblong, turriculate, notched anteriorly; columella smooth, rounded, with conspicuous callosity, Buccinum (*alveolatum*) 1, Cominella 5, Adamsia 1, Nassa 5. Eburna 1.

Family, Purpuridæ.

Animal: Head small, two conical tentacles often obtuse, in the middle of which are the eyes; foot short, elliptic; *operculum* horny, with a lateral nucleus. *Shell* smooth, tuberculous or spiny; columella flattened, pointed, aperture wide with an oblique notch. Purpura 6 (this includes one of the family of Coralliophilidæ of *Chenu* our *P. madreporarum*, but the Tasmanian shell does not live on corals).

Family, Olividæ.

Animal: Almost covering the shell; foot very large, with two auriculate lobes in front; *operculum* rudimentary. *Shell* polished, spire almost always very short; columella often twisted, callous.

Ancillaria 2, Oliva 1.

Family, Fasciolaridæ.

Animal, with an enclosed mantle and a straight siphon. *Operculum* ovate acute, nucleus apical. *Shell* fusiform, with a straight canal and plaits on the fore part of the pillar.

Fasciolaria 3. Josephia 1. The latter a genus which perhaps might belong to the Buccindæ.

Family, Volutidæ.

Animal: Head large, eyes sessile, placed at the back of the tentacles, a reversed and auriculated siphon, very large foot partly enclosing the shell. No operculum, one single line of teeth. *Shell* highly coloured, ovate, or fusiform, smooth or tuberculate with distinct folds on columella. Voluta 7, Mitra 14, Marginella 8, Erato 1.

Family, Columbellinæ.

Animal: Head large, flat, foot narrow, elongated, oval, siphon short, no operculum. *Shell* short with a periostraca, spire short aperture rather narrow often toothed on the outer margin, a slight notch at the anterior end of aperture. Columbella 10.

Family, Cassidæ.

Animal: Head large, thick with fine tentacles, eyes at base, siphon extensile, thick and salient, mantle with filaments and a double fold. *Operculum* horny, Odontophore, 3-1-3. *Shell* solid, globose, more or less tubercular, aperture narrow, canal abruptly recurved. Cassis 4.

Family, NATICIDÆ.

Animal, very large, head small, tentacles wide apart, united by a veil-mantle almost covering the shell, eyes none or minute, *operculum* multispiral and horny, often with a second calcareous plate. *Shell* large, globose, smooth, spire short, aperture large, almost round, with an umbilicus or a callosity. *Odontophore* short, 3-1-3, central quadrate, broad based.

Natica 4, Ruma 2, Sigaretus 1.

Family, SCALARIDÆ.

Animal, cylindric, foot short, sub-quadrangular, head short obtuse flattened, tentacles conical, eyes at the external base. *Operculum* horny, 1 or 1½ whorled, nucleus central. *Odontophore* with no central teeth, but simple transverse rows of teeth. *Shell* turriculate with ribs, mouth entire, round, reflected. Scala* 8.

Family, TEREBRIDÆ.

Animal: Head large, tentacles small, a rather long siphon between, mouth at the end, *operculum* oval, horny. *Shell* very long, conical, with a notch in the aperture.

Terebra 4 (though others are described).

Family, PYRAMIDELLIDÆ.

This is a rather heterogeneous family, as will be seen by the genera included in it by various authors. M. Chenu makes it receive such genera as Ringicula. Messrs. Adams's definition is less than that of Gwynn Jeffreys, who includes Stylifer. But following his arrangement we should have the Families Pyramidellidæ with Turbonilla 4, Odostomia 2, Aclis 1, Fam. Eulimidæ, Eulima 5, Elusa 1, Syrnola 2, Stylifera 1, Styloptigma, Cingulina 1, Acus 1. All small shells, agreeing generally in their terriculate habit and entire mouth, with or without plaits on the columella.

Family, CERITHIOPSIDÆ.

Animal: Head short, broad, tentacles subulate obtuse, eyes at base, mouth with retractile probocis, mantle not reflected with rudimentary siphonal fold, *operculum* horny, on a well developed lobe. *Shell* turreted, many-whorled, spirally keeled. *Odontophore* like Naticidæ. Cerithiopsis 2.

Family SOLARIDÆ, doubtfully represented, no species determined.

Family, CONIDÆ.

Animal: Head with produced tubular veil, tentacles subulate, eyes on tubercles at outer side, mantle enclosed, an elongate siphon at fore part, foot simple, undivided, oblong, conspicuous

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* This name is Klein's, and before Linnæus, but we may adopt it as it is shorter and not much different from Lamarck's.

aquiferous pore on middle of under surface. Teeth subulate in two series, on tubular prolongation of retractile proboscis, bundle of sharp subulate teeth at extremity. *Shell* inversely conical, aperture long and narrow, outer lip thin, free or notched near suture. Conus 5.

Family, CYPRÆIDÆ.

Animal, elongate, mantle very large with many cirrous filaments, almost concealing shell, tentacles very long, eyes upon a protuberance, siphon short. *Odontophore* with seven rows 3-1-3, branchial plume single, no operculum. *Shell* in general like cowry. Cyprea 6 (one doubtful), Trivia 1, Birostra 1.

Family, CANCELLARIDÆ.

Animal, with subulate tentacles united at the base, eyes at the outside, foot small, simple and triangular without operculum, spire short, whorls convex, often cancellate and ribbed, mouth entire, no odontophore, rostrum rudimentary. Cancellaria 4.

Family, CERITHIIDÆ.

Animal, with a large foot, short, and angular, a front mantle with anterior rudimentary siphonal fold, rostrum large, short, folded, eyes at external base of tentacles, which are subulate and very wide apart. *Odontophore* long linear, 3-1-3, conical, curved. *Operculum* horny, subspiral. *Shell* turriculate, many whorls, notched at the anterior aperture, labrum produced.

Cerithium 3, Lampania 1, Bittium 4, Triforis 1.

Family, LITTORINIDÆ.

The family of Perrywinkles, best characterized by that name. See Proc. Linn. Society, N. S. Wales, June, 1878, for the reasons why I only make one genus Littorina of Risella, Tectaria, of which we have probably four species in Tasmania. Fossarus 2, Ampularina 3, Fossarina 1.

Family, PLANAXIDÆ.

Animal, with a long rostrum, subulate tentacles, eyes sessile on the swollen exterior base, foot short, simple with small tentacular filaments, operculum thin, horny paucispiral, *odontophore* 3-1-3, and in general much like the perrywinkles. Tasmanian representatives (included doubtfully), Diala 3.

Family, RISSOIDÆ.

Small white or horny shells of various forms, but more or less turriculate. *Animal* with a proboscidiform head and subulate tentacles, eyes at base, foot long, sub-triangular truncated in front. *Odontophore* with a 3-1-3 inner lateral; teeth very broad, outer dissimilar; all with denticulated apices.

Rissoa 12, Rissoina 7.

Family, TURRITELLIDÆ.

Animal: Rostrum short, broad, tentacles long, fine, eyes at base. Mantle with a fringed margin obscurely siphonated at right side. *Operculum* horny. *Odontophore* very short, 3-1-3, median square, laterals ligulate, summits hooked, serrulate. *Shell* turreted, subulate many-whorled imperforate, spirally grooved, aperture entire, outer lip acute.

Turritella 5. Siliquaria 2. Vermetus is also placed in a different family. We have two of the former and one of the latter, or perhaps two. Both are abnormal mollusca—the latter fixed, and with the foot rudimentary. Lingual dentition unknown.

Family, CALYPTRÆIDÆ.

Animal dilated and depressed on its sides, tentacles medium, eyes at their external base, foot large, no operculum. *Odontophore* winged on each side in front, 3-1-3, central small, broad, lateral long, hooked, gill a single plume. *Shell* limpet-like, apex subspiral, interior simple or with a diaphragm. The egg-cases in this family are membranaceous in a tuft in front of foot, under the neck. Trochita 1, Concholepas 2, Crepidula 1 or 2.

It is doubtful whether some of the species ranged under the above genera should not be placed in others. In the family *Pileopsidæ* they are not known from the animals. *Amalthea*, of which we have probably two species, is referred to the latter family, which generally corresponds to Adam's *Capulidæ*. The animals hardly differ in either.

2ND ORDER, SCUTIBRANCHIATA.

Hermaphrodite molluscs, with a double branchial plume in the neck, or in cirrhi round the foot.

1. Sub-order, Podophthalma—eyes pedunculate.

Family, NERITIDÆ.

Animal: Muzzle broad, short, tentacles slender, eyes on stout peduncles at outer base, no head lobes or neck lappets, foot oblong, triangular, no filaments, operculum shelly, articulated, subspiral, operculum central, teeth 5-1-5, with a long comb of very numerous laterals. *Shell* depressed, oval, spire short, no umbilicus. Nerita 1.

Family, TROCHIDÆ.

Animal: Head proboscidiform, tentacles fine, often ciliated, eyes on free peduncles at their outer base, head lobes between tentacles, gill single, long, neck lappet at sides of foot near eye peduncle, continuous with a side membrane with 3 to 5 filaments on free margin, operculigerous lobe ornamented with cirrhi, operculum horny, spiral, often calcareous. *Odontophore* like Neritidæ. *Shell* pyramidal, turbinate, or ear-shaped, pearly

within. Phasianella 5, Turbo 4, Carinidea 2, Astele 1, Liotia 5, Cyclostrema 7, Monilea 2, Ethalia 1, Adeorbis 1, Minolia 2, Clanculus 13, Euchelus 3, Thalotia 4, Zizyphinus 7, Elenchus 4, Bankivia 1, Gibbula 6, Trochocochlea 2, Trochus (Diloma) 2, Stomatella 1, Gena 1.

Family, HALIOTIDÆ.

Animal: Head large, flat, tentacles long, eyes on terminal peduncles, foot very large exceeding the shell, and fringed, Branchial plumes two, no operculum, shell ear-shaped, nacreous. The *Odontophore* is like Trochus 1 median, two beam-like laterals, and numerous uncini with denticulated hooks, the four inner very large. Haliotis 4.

Sub-Order EDRIOPHTHALMA, eyes sessile.

Family, FISSURELLIDÆ.

Animal: Head with short wide muzzle, body broad, conical, tentacles short, fine, eyes at base on protuberances, mantle margin fissured in front, free edges forming an oval siphon through apex of shell, gills two at back of neck, foot dilated upper sides with rudimentary filaments. No operculum. *Shell* not nacreous, conical, perforated at the apex or slit.

Fissurella 4, Macroschisma 1, Emarginula 4, Scutus 1, Tugalia 1.

Family, DENTALIDÆ.

Animal, long, conical, truncate entirely enveloped in a mantle terminated in a fringed or plicate varix, foot proboscidiform, head distinct and pedunculate, lips with tentacles, but no other filaments or eyes. Dentalium 2: but there are others which may belong to the genus *Cæcum*, which is a family by itself near to the Vermitidæ.

Family, TECTURIDÆ.

Animal like preceding, but with gill plume at back of head. *Odontophore* long, two central and two hooked lateral teeth on each side in an oblique line. *Shells* like limpets, apex not central. Acmæa 9.

Family, PATELLIDÆ.

Animal like preceding, but with gills in cirrhi all round foot. *Odontophore* very long, teeth simple in numerous transverse rows. *Shell* a simple cone. Patella 6 or 7.

Family, CHITONIDÆ.

Animal elongated. Gills in lamellæ, placed like last. Heart central, alimentary canal terminating at end of median line. *Odontophore* not long, teeth 3 central, median small, laterals large, with dentated hooks, uncini five. *Shell* of numerous plates, Chiton. 6 ? Cryptoplax 2.

Sub-class, OPISTHOBRANCHIATA.

Hermaphrodite molluscs, branchia always posterior uncovered, or only covered by a fold of the mantle. Sheli external or internal, testaceous, membranceous, rudimentary, or none.

1st Order Tectibranchiata. Branchia covered by shell or fold.

Family, CYLICHNIDÆ.

Animal with frontal disk, head sub-quadrate, truncate in front, produced behind into broad flattened recumbent lobes, with eyes immersed in front of their bases, mantle with posterior thickened lobe, foot shorter, thin shell truncate in front, no operculum. *Odontophore* 6-6, no median, inner large and hooked, outer uniform. *Shell* without colour, cylindrical, spirally convoluted, spire short. Cylichna 2, Tornatina 1.

Family, BULLIDÆ.

Animal, partly or wholly covering shell, frontal disk expanded, no eyes or sessile on frontal disk, mantle with right margin thickened, left thin. *Odontophore*, one central tooth and lateral numerous in an arched series, gizzard with calcareous plates, foot expanded for swimming. Shell thin ventricose, spire none. Bulla, 1, Haminea, 1. I include in this Philine 1, but the shell is wholly covered and the head differs.*

Family, APLYSIIDÆ.

Animal large, eyes sessile, tentacles (?) ear-like, mouth with tentacles, mantle with internal calcareous plate protecting gill. *Odontophore* broad, short, teeth, central one, lateral numerous similar, gizzard with cartilaginous plates. Aplysia 2.

Nothing has been done hitherto with the Nudibranchiate molluscs, and I need not pursue the classification for the brackish water shells, such as Ophicardelus 2 and Auricula, as they are so widely separated from the other families that it would extend this essay too long to explain the intermediate system. Our Marinula is a marine shell, and until the animal is studied and known I should hesitate on what system to place it. The Family SIPHONARIDÆ is also very far removed. It is distinguished by a pulmonic cavity for respiration, a conical shell, and a short ligulate odontophore, with one small central tooth and an immense number of laterals.

The length to which this paper has extended prevents me from giving a synopsis of the Conchifera, to which I may return on a future occasion, as well as to the Land and Freshwater mollusca.

I wish to conclude with some observations on the geographical distribution of the species. I have already published my opinion that for convenience it would be well to divide Australia into several molluscan provinces. The S.E. coast forms one, Victoria

* The *Bullina lineata* of Wood found at Port Jackson has a horny operculum.

another, South Australia, as far as Eucla, another, and Western Australia another. In this sense we should have to divide Tasmania into two provinces. The north side, which would have its relations with the South Australian coast, and the eastern and southern, which would be found more in relation with the S.E. province of Australia. But just as there is in all these provinces the same general character, or as we term it, the same Australian facies, so in Tasmania,—it has the most of the species which are very common on the South Australian coasts. Beginning with the littoral shells, we have the same *Patella* (*P. tramoserica* Chem.) on the rócks of New South Wales, of Port Phillip, or South Australia, but it differs a good deal in character. In its young state it is streaked with bright vermilion in Victoria; on the New South Wales coast it is often a rosy red; in South Australia it is of a beautiful golden yellow; while in South Tasmania it is a dull leaden colour, and attains a much larger size than anywhere else. Perhaps the two most common shells on all the south coast of Australia are *Phasianella tritonum* and *Turbo undulatus*. Every one is familiar with the former of these shells, which assumes such astonishing varieties of colour, all of great beauty. It would be hard to find any part of the Tasmania coast where they are not washed up on the beach; but as we proceed south they become more scarce, *T. undulatus* especially so. On the other hand, the common coast shell of Tasmania is the beautiful *Venus lamellata*. On the beach of Sandy Bay, near Hobart Town, they are drifted up in immense numbers at times. The same shell is common on the north coast, and on the South Australian coasts they are considered great rarities. A shell that is very common throughout Tasmania, and equally common on all the south coasts of Australia, is *Buccinum alveolatum*, Kiener. The animal acts as a kind of scavenger to the coast. Its powers of sight or scent must be very keen, because if a large limpet is cut out of its shell and thrown into a rocky pool it is in a very short time completely covered with this mollusc. It has a long siphon or proboscis, which contains the *radula*. This is a thin sharp spear-like instrument, strongly barbed on each side. It evidently tears away the muscular tissue with great facility.

Taking Southport, Port Esperance, or Recherche Bay in South Tasmania as places for comparison, we find a very marked difference from the Australian coasts. The rocks are covered with *Patella tramoserica*, *P. ustulata*, *Acmæa altcostata*, *A. marmorata*, *A. septiformis*, *Siphonaria zonata*, *S. diemanensis* *Littorina* (Risella) *melanostoma*. (*L. nana* and *aurea* occur, but I have shown that these are simple varieties.) *Trochocochlea australis*, *T. constricta*, with the variety *T. tæniata*, *Diloma odontis*, *Littorina cærulescens*, the many varieties *ziczac*, *Phillipi*, &c.

All these shells are between the tide marks. A little further from the shore we find *Haliotis nævosa*, *Carinidea aurea*, *Cominella costatum*, *Purpura littorinoides*, *Ostrea edulis*, and in sandy places *Venus roborata*, *V. gallinula*, *V. conularis*, *Pecten asper*, *P. bifrons*. There are also three species of *Mytilus* in thick patches on some of the rocks, *M. latus*, *M. rostratus*, and *M. hirsutus*. In this list I mention only the most common shells, to which I may add in places, *Chiton petholatus* and *C. australis*. Compare this now with Guichen Bay on the South Australian coast. We still find *Patella tramosereca* and *Acmæa alticostata* and the usual varieties of *Littorina*. But in place of the *Trochocochlea australis*, which in Tasmania swarms under every stone, we find large numbers of a *Thalotia*, *T. conica*, with occasionally *T. picta*, and the variety (which is regarded as a species by Messrs. Crosse and Fischer), *T. Ramburi*, *Elenchus bellulus*, *E. badius* and *E. irososodontis* are also very common and very large, but not upon the rocks; they are found feeding on the sea-weeds a little way out from the shore. Now all of these shells are found on the north coast of Tasmania, but the genus *Thalotia* is not at all common. On South Tasmania it is never found so far as I could learn. *Elenchus bellulus* is found rarely in Bass's Straits. *E. badius* is not at all rare in any part of Tasmania, but rather smaller. The finest and commonest specimens appear to be found at Lacepede Bay, a little north of Guichen Bay. *Nerita atrata*, a very common shell above tidal marks on the south and south-east coast of Australia, is rarely found on the south coast of Tasmania. *Haliotis nævosa* is common through all the S. E. and S. coasts, and in Tasmania everywhere; it forms an article of export to some Chinese fishermen on the south coast. *Haliotis albicans* is found only on the north coast ; it has not been found in Victoria, and is more generally on the S. A. coast.* The Littorindæ of Tasmania generally are those of the Australian coast, except *Littorina scabra*, and *L. pyramidata* so common on the south-east. The latter is found on the north Tasmanian coast, but rarely and very small. *Ostrea mordax*, so abundant in N. S. W., is almost entirely absent from Tasmania. *Cardium cygnorum*, from W. Australia, occurs on the north T. coast, but small and thin. It occasionally extends to N. S. W.

These remarks might be very much extended, but sufficient has been said to give a general idea of the differences of the fauna, and as the subject is too large to be disposed of in one paper, further details may form the subject of a future essay. In conclusion, I give a list of those fossil forms more or less abundant in our tertiary strata which are found living in Australia.

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* This shell was first named *H. glabra* by Swainson, but as that name was preoccupied, the name *albicans*, of Quoy, by which it is generally known, may be adopted.

Pecten laticostatus, south coast only, small and rare. *Limopsis decussata*, doubtfully on the north coast. *Cylichna arachis*, common. *Liotia discoidea*, rather common. *Fissurella concatenata*, rather rare, and in Sydney.

Discussion.

The Chairman said, precisely the same thing occurred with the vegetable kingdom as with the animal, as described by Mr. Tenison-Woods. Along our own coast and the coast of Queensland there were upwards of 200 species of ferns, whereas on the west coast of Australia there were not more than two or three species. As we go to the southward and westward the number of ferns decreases, while as we go to the north the number increases. There was nothing so marked in the vegetation of this country as the want of ferns in the southern part of Victoria, South Australia, and Western Australia; whereas there was nothing more marked than the large number of ferns on the eastern coast. Some of them attained a very great height. Some of them did not extend beyond the Dandenong Range, west and south. (Mr. Tenison-Woods: I do not think there are any in South Australia.) No, but in this country they abound, and reach a height perhaps equal to any in the world. On the Blue Mountain Range they attain a height of about 60 feet. He desired to make a suggestion with regard to the discussions on their papers. The late Sir William Denison endeavoured to get short papers read in order to excite discussion. He believed if they had short papers read, they would excite discussions that would be both interesting and instructive to the members of the Society.

Dr. Neild thought, with regard to the suggestion of the Chairman, the idea about discussions could be carried out in even a simpler way, namely, by members having the power to propose certain subjects. He was a member of an institution in England, and they met once a month and had exceedingly valuable discussions in this way. He thought the idea, if carried out, would lead to profitable results, and greatly increase the interest of the meetings.

The Chairman thought that could only be done by means of short papers.

On some Australian Tertiary Fossil Corals and Polyzoa.

By the Rev. J. E. Tenison-Woods, F.L.S., F.G.S., Hon. Mem. Roy. Soc. N.S.W., &c., &c.

[*Read before the Royal Society of N.S.W.*, 4 *September*, 1878.]

Last year I published in the Proceedings of this Society (vol. 11, p. 183) a description of some tertiary fossil corals from the Muddy Creek beds, Western Victoria. Since then I have found others amongst the detritus and matrix of fossils in my possession. They are of especial interest, not only from the beauty and peculiarity of their form, but also because of the new facts they contribute to our tertiary paleontology and the structure of corals generally. In the first place I am able to signalize the discovery of a *Montlivaltia* in our tertiary beds, and this is another link to that chain of facts which gives our tertiary fauna such a mesozoic aspect. I allude especially to the discovery of *Salenia* and *Belemnites* in the Aldinga beds, *Thamnastræa* in Tasmania, our simple endothecal corals generally, and *Pleurotomaria*, *Trigonia semiundulata*,* &c., among the mollusca. Most of these genera have probably living representatives, though they were at their highest development long before the dawn of the tertiary period. *Montlivaltia* is a similar instance. The genus was established by Lamouroux (*Expos. Méthodique des genres de l'ordre des Polypiers*, Caen, 1821, page 78) for a trochoid simple free coral found in the jurassic limestone near Caen. It includes at least a hundred species, the most of which are found in the jurassic or the chalk formations. There are about ten tertiary species known, but none living. The tertiary species are Eocene and Miocene. The forms of this coral vary very much, from conical to discoid. I cannot find that one form is more peculiar to any given period than another. The discoid corals are few in number, and it is to this kind that the fossil to which I draw attention belongs; but it is a discoid form which is flat or even concave beneath, and that is, I believe, rare in the genus. There is a fossil form lately described by Mr. Tomes

* This *Trigonia* is a remarkable instance, as it is so different from our living species and so like some mesozoic forms.

(*Jour. Geol. Soc.*, vol. 34, p. 193) from the Lias of Warwickshire, which is very like our species, but it is attached while the present is free. The following is the diagnosis:—

Family ASTREIDÆ. Div. LITHOPHYLLIACEÆ.

MONTLIVALTIA DISCUS. *Corallum* circular, depressed, convex, but slightly depressed in the centre. *Costa* corresponding with septa, faintly visible under the epitheca, covered with rather large but faint rounded granules. *Epitheca* thick, smooth, showing scarcely any concentric lines of growth. Systems six, cycles four. *Septa* moderately thick, regularly and finely dentate, the serrations extending as ridges far along the higher orders; moderately granular. Primaries nearly always free to the centre. Tertiaries curving round and joining secondaries at about three-fifths from centre, but the secondaries are not subsequently thicker. Fourth and fifth orders curving round and joining the tertiaries, but the fifth order always nearer the centre than the fourth. Endotheca abundant, no interseptal space without one or two dissepements, thick, curved, sloping. *Base* concave, and no trace of attachment. In some cases the secondary septa of some systems curve suddenly and join the primaries close to the centre. Diameter, 6½, alt. 2 millims. Muddy Creek; not very abundant.

There is a coral described by Professor Duncan from the Australian tertiaries which is very like this species. It is named *Antillia lens*, and from the Professor's description I judge the differences to be that it has a columella, the septa do not unite in the manner here described, and the endotheca is not abundant. In all other respects they might easily be mistaken for one another.

The next fossil I have to describe is one of most singular and interesting characters. It is a combination of some of the leading characteristics of several families and sub-families. It is a Turbinolidian coral with pali, without a columella and a perforated wall! It is well known that the perforation and non-perforation of the walls of corals form two of the largest subsections of the MADREPORARIA. The perforated section is less diversified than the other, since it generally possesses other marked features in combination. In this fossil we have a perforated wall, but none of those features. In exterior form it is very like a *Turbinolia*, and like some members of that genus it has what seem to be deep pores between the costa. But in the true Turbinolia these pores go no further than the wall. They follow a groove between the costa and, though deep, they never go through. In the fossil I am describing they go right through the wall, in fact, as the pores are very large, the portion of the wall which separates them becomes little more than a flat transverse bar, an arrangement which reminds us of *Porites*. There

are other peculiarities which I will notice in the diagnosis; it is sufficient here to call attention to the singular beauty of the design of these corals. They might be made serviceable as designs for ornamental purposes, a suggestion which has more than once been made with regard to other members of this order.

The affinities of this species are all with *Conocyathus*, a genus which, in addition to being Australian, has several fossil members in our tertiary beds. The perforation of the wall is, I think in this case, a generic feature, at least, if it should not be the representative of a family. We have in *Dasmia* a family with a single species, but others may be found for ours, as the beds in which this fossil occurs are so little explored. I propose to name the genus from its perforated aspect *Trematotrochus*, which is thus characterized:—

TREMATOTROCHUS, new genus.

Corallum free, with the visceral chambers free, the septa distinct, only united in the middle, pali present; no endotheca or synapticulæ and the wall incomplete, so as to leave large interstices at regular intervals. No epitheca. TREMATOTROCHUS FENESTRATUS. *Corallum*, a regular cone, cylindrical, finely pointed, without trace of attachment. Costa in three cycles, the third order branching off very close to the base, rather prominent, thin and closely covered with short blunt spinous granulations. Marginal edge of calice rounded. No fossa. *Septa* exsert in rounded lobes spinously granular at the edges like the costa. Systems six, cycles two. Secondaries very much smaller than the primaries. Pali before both the orders in rather stout granular processes, not rising so high as the septa. In addition the septa sometimes send out long narrow lobes such as recall the Astrangiaceæ, which join the pali. Dimensions, alt. 5, diam. of calice 2½, of rounded base 1. Rare at Muddy Creek. Only two specimens found by me sufficiently well preserved to show details.

I am now of opinion that the coral which I described in last year's proceedings as *Conocyathus fenestratus* was no other than a very much worn specimen of the present fossil. The interstices were filled up with sediment.

It will be observed that in the case of this fossil, as in many other fossil and recent corals which are found in Australia, there is one cycle of costa more than the septa. I have figured for the plate which accompanies this a remarkable fossil from Aldinga, which has a structure which may throw a light upon this peculiarity. In *Trochocyathus heterocostatus* we have costa in cycles, and though they correspond with the septa, yet it is the higher orders (the fourth and fifth) which are continuous to the base, while the costa corresponding to the primaries and tertiaries do not appear until about half way. The fourth and fifth orders of

septa are only rudimentary; so that if we found this coral in its young stage we should have no fourth cycle of septa, and no primary and secondary costa. Thus the costa would alternate with the septa. We see in this, probably, a proof that an extra cycle of costa shows that a cycle of septa to correspond with them either will appear or is aborted. It would be very interesting to learn if there are tentacles in the animal to correspond with the extra cycle of costa, or organs of any kind that will account for the irregularity. In *Trochocyathus heterocostatus*,* the primary costa at the end of the major axis are continuous to the base, and even wider than the fourth and fifth order. This shows us something of the mode of growth, which may be of interest in tracing the homology of these organs. It seems very certain that the new forms which Australian paleontology is bringing forth will hereafter throw much light on the meaning of many of those facts which an imperfect knowledge of the plan of nature has rendered apparently anomalous, and which may eventually lead to a more sound system of classification than that at present adopted.

Class, POLYZOA. Order, *Infundibulata*. Sub-order, *Cheilostomata*. Section, *Inarticulata*. Sub-section, *Bi-multiserialia*. Family, *Gemellariadæ*. Cells opposite, in pairs.

The fossil which I am about to describe is close to *Gemellaria*, wherein the cells are joined back to back, and all the pairs face the same way. But in this species the faces alternate in two ways—that is, the faces are on all four sides of the almost cylindrical branches, and they alternate in each of the opposing cells arising on the side of the centre of its alternate neighbour. This peculiarity is of generic value, and I propose the name of *Tetraplaria* for the genus. A fossil similar to this has been included in the genus *Cellaria* by A. E. Reuss.† It is a Miocene form of the Vienna basin, which the author thus describes: CELLARIA SCHREIBERSI. *C. gracillima, raro dichotoma, cellulis quadrifariis ovatis aut semi-cylindraceis, plus minusve convexis, medio punctatis apertura supera, immersa, late elliptica, poris duobus minimis lateralibus.*

The specimen figured by me differs from this in the cells being smooth and not punctate.

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* This fossil coral has been described by me in the Proceedings of the Adelaide Philosophical Society for this year, along with all the corals found by Professor Tate in the Aldinga beds.

† *Fossile Polyparien des Wiener Tertiar Beckens.* Vol. 2, p. 63, plate 8, fig. 8.

TETRAPLARIA, nov. gen.

P. with cylindrical smooth branches. Cells back to back, facing four ways, the opposite pairs of two sides alternating with the other two.

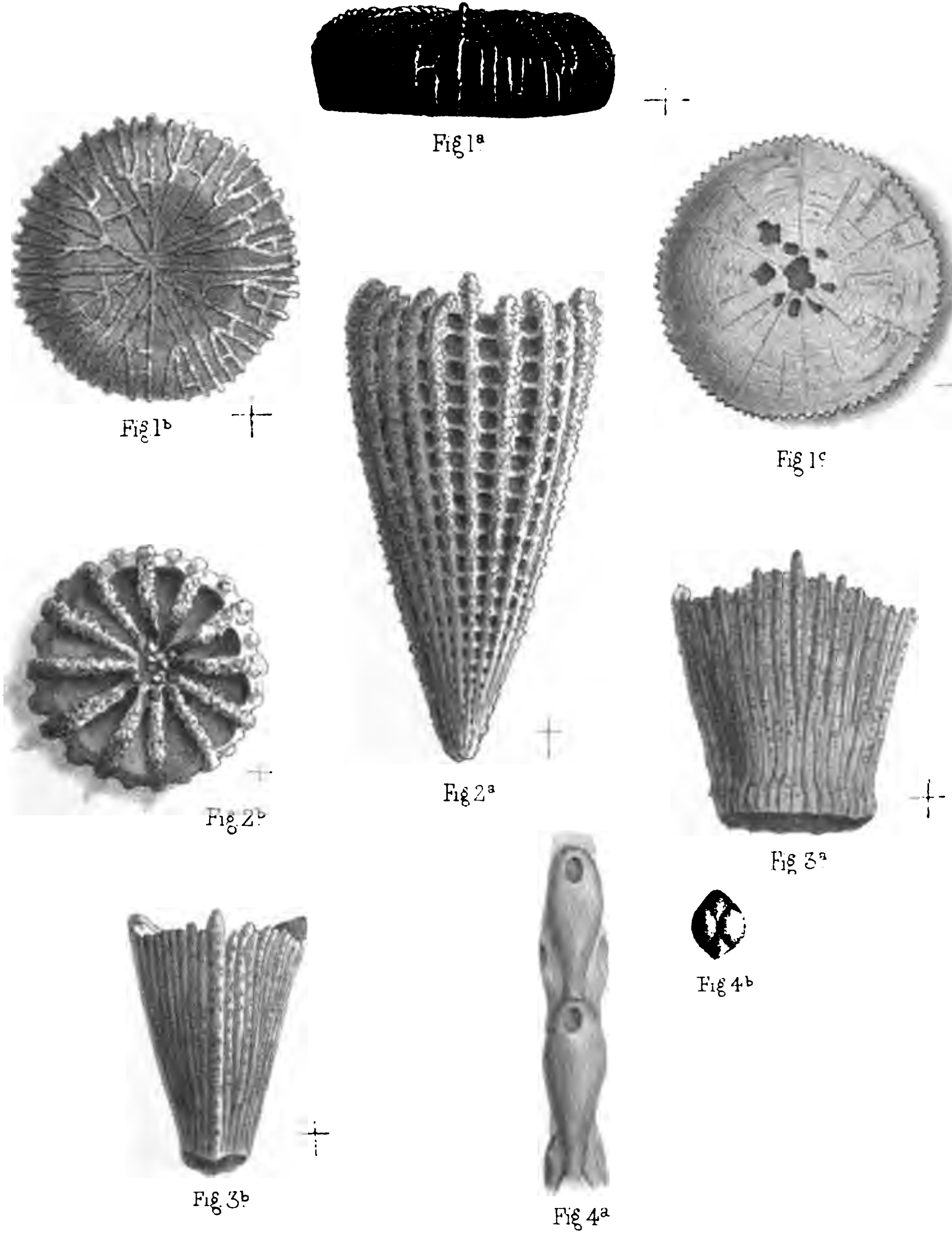
TETRAPLARIA AUSTRALIS, n. s.

P. with smooth slender branches. Cells elongately pyriform, not punctate; aperture nearly oval.

Muddy Creek, Western Victoria.—The occurrence of a fossil form so very near the Vienna miocene species, and of a genus which, as far as I am aware, has no pliocene or living representative, is another link in the chain of evidence which fixes the age of these beds.

EXPLANATION OF PLATE.

Fig.	1a.	*Montlivaltia discus*, enlarged.	
„	1b.	Ditto	calice.
„	1c.	Ditto	base
„	2a.	*Trematotrochus fenestratus*, much enlarged.	
„	2b.	Ditto	calice.
„	3a.	*Trochocyathus heterocostatus*, enlarged.	
„	3b.	Ditto	end view, showing peculiar costa.
„	4a.	*Tetraplaria australis*, enlarged.	
„	4b.	Ditto	section.



J. E. Tenison-Woods Delt — S. T. Leigh & Co Lith. Pitt St Sydney

Fig 1^{a} Montlivaltia discus, (enlarged)
Fig 1^{b} Ditto Calice
Fig 1^{c} Ditto Base
Fig 2^{a} Trematotrochus fenestratus, (much enlarged)
Fig 2^{b} Trematotrochus, Calice
Fig 3^{a} Trochocyathus heterocostatus, (enlarged)
Fig 3^{b} Ditto end view showing primary c…
Fig 4^{a} Tetraplaria australis, (much enlarge…
Fig 4^{b} Tetraplaria australis Section

Proposed Correction to the assumed Longitude of the Sydney Observatory.

By John Tebbutt, F.R.A.S.

[*Read before the Royal Society of N.S.W.*, 5 *June*, 1878.]

One of the most important problems to the colonists, from an astronomical, a nautical, or a geographical point of view, is the accurate determination of the longitude of the Sydney Observatory. Four methods may be mentioned for this determination, namely, the transportation of chronometers, observations of moon-culminations compared with corresponding ones at Greenwich, observations of lunar occultations of stars, and exchanges of telegraph signals between Europe and the Observatory. Of these four methods, only one has hitherto been employed, namely, observations of moon-culminations. During the latter part of the year 1859, the Rev. W. Scott, the then Government Astronomer, observed forty-eight meridian transits of the moon, namely twenty-six of the first limb, and twenty-two of the second. These, compared with the tabular positions in the *Nautical Almanac*, gave 10h. 4m. 59·9s. E. as the longitude of the Observatory from Greenwich; and this is the value hitherto adopted in the *Nautical Almanac* and the *Astronomische Jahrbuch*. During the year 1860 fifty other meridian transits were observed, namely, twenty-six of the first limb, and twenty-four of the second. These likewise, compared with the tabular positions in the *Nautical Almanac*, gave 10h. 5m. 6·84s. E. as the longitude. In the year 1861 fifty-six transits were observed. From the assemblage of observations obtained in the years 1859, 1860, and 1861, a selection was made of those transits which had corresponding observations at the Cape of Good Hope and Greenwich Observatories. It appears from a discussion in the volume of "Sydney Astronomical and Meteorological Observations for 1861," page 82, that twenty-three transits in 1859, compared with corresponding ones at the Cape of Good Hope, give 10h. 4m. 44·43s. E., and that thirty-three in 1860 and 1861, compared with corresponding ones at Greenwich, give 10h. 4m. 46·66s. E. as the longitude—the mean result being 10h. 4m. 45·74s. E. In vol. xxvii of the Royal Astronomical Society's Monthly Notices, page 299, there is a paper on the longitude of the Sydney Observatory, by Mr. Stone, the present Astronomer Royal at the Cape of Good Hope. In that paper he has compared sixteen transits of the moon's first limb, and eight of the second, observed at Greenwich and Sydney in 1859, the resulting longitudes being respectively 10h. 4m. 45·05s. and 10h. 4m. 48·08s. E. He has also compared thirteen transits of the first limb, and eleven of the second, observed at both places in 1860, with the respective results—10h. 4m. 45·81s.

and 10h. 4m. 50·05s. E. Combining the observations of the two years, he got for the resulting longitude—10h. 4m. 45·39s. E. from observations of the first limb, and 10h. 4m. 49·26s. E. from observations of the second limb; or, as the final result, 10h. 4m. 47·32s. E. This value differs only 1·58s. from the Rev. W. Scott's, before stated. The discussions by the Rev. W. Scott and Mr. Stone, so far as I am aware of, are the only ones that have yet appeared.* I believe, however, that the method of moon-culminations must yield in point of accuracy to that founded on lunar occultations of stars. While the Greenwich corrections to the moon's tabular places in the meridian depend, of course, upon observations made by thoroughly practised observers with the great transit circle, whose telescope is an instrument of about 8 inches aperture and nearly 12 feet focal length, and a clock of the highest class, the transits at Sydney were observed with a telescope of only 3¾ inches aperture and 62 inches focal length, with a clock of not first-rate quality. The determinations of right ascension at Sydney cannot, therefore, compare in point of accuracy with those made at Greenwich. What we want here, therefore, are observations which are more nearly comparable in precision with those made at Greenwich, and these, I believe, are to be found in observations of lunar occultations of stars. An occultation, it is well known, can be observed within a fraction of a second of time, and if the moon's disc were a perfect circle, and the tabular elements could only admit of being corrected at Greenwich with the same degree of accuracy, the resulting longitude would be correct within a second of time. Professor Newcomb, in his "Investigations of Corrections to Hansen's Tables of the Moon, Washington, 1876," says that the determinations of longitude from moon-culminations are found by experience to be subject to constant errors which it is difficult to determine and allow for, and that it was, therefore, a part of the policy of the American Commission for the observation of the transit of Venus to depend on occultations, rather than upon moon-culminations, for the determination of longitudes. I am not aware that any attempt has yet been made to fix the longitudes of either the Sydney or Melbourne Observatories, or, indeed, of any other position in this or the adjacent Colonies, by means of observations of lunar occultations of stars. I have, therefore,

* The principal portion of the preceding paper was written previously to the last meeting of the Astronomical Section of the Royal Society, hence there is no mention made of the result recently arrived at for longitude by the present Government Astronomer. At that meeting a paper was read by him based on numerous moon-culminations observed by himself in the years 1863, 1871, 1872, 1873, and 1874. He gives for the resulting longitude 10h. 4m. 50·81s. E. (see *Herald*, May 7th, 1878), which differs only 2·57s. from that derived from the occultation observations. It must be remembered, however, that all the moon-culminations referred to have been observed by means of the old transit circle of 3¾ inches aperture.

thought it would be desirable to investigate the problem and lay the results before our Society. If the longitude of any point in the Colony could only be accurately determined in this way, that of any other point could readily be determined by exchanges of time signals with the electric telegraph. I thought at first to include the observations of solar eclipses in my investigations, but as these phenomena cannot be observed with the same precision as an occultation I considered it advisable to reject them. I am not aware if any occultations have been systematically observed at Sydney. During the period 1863–1877, however, I have succeeded in observing one hundred and sixty-nine of these phenomena at Windsor. By far the great majority of the stars so observed have not yet been catalogued with sufficient accuracy, and have been observed only at the dark limb during the first semi-lunation. I have selected twelve stars for the discussion of the longitude of my observatory observed previously to 1875, and for which I am enabled to get the Greenwich corrections of the moon's tabular places. They have all been observed at the dark limb during the first semi-lunation. Their positions depend on numerous observations made at Greenwich, Radcliffe, Washington, and Melbourne, and may therefore be considered fixed with almost absolute accuracy. For the computations I have adopted—33°36′ 28·9″ as the astronomical latitude of my observatory. This value rests upon ninety-three prime vertical observations with a transit instrument of 2·1 inches aperture and 20 inches focal length, of stars culminating within 39′ of the zenith, whose positions have been determined in the Southern Observatories of Sydney, Melbourne, and Williamstown. Fifty-nine observations were taken on the centre wire of the instrument, and thirty-five on one of the side wires, with the transit both direct and reversed, both before and after the meridian passage. In this way each star was observed on the same wire four times for each complete observation. Rejecting only one observation for discordance, I obtained the following results for each class of observations :—

Mean of 59 observations on the centre wire—33°36′ 28·8″
„ 34 „ „ a side wire ...—33°36′ 29·2″
The mean result, as before stated, is ....—33°36′ 28·9″

With the exception of the discordant observation before mentioned to have been rejected, the extremes of the individual results are—33°36′ 20·9,″—33°36′ 37·7″. It will therefore be seen that any further correction to the latitude must be very small, and not likely appreciably to affect the computed longitude. Adopting now Bessel's ratio of the squares of the earth's semi-axes, or $\frac{B^2}{A^2}=0·9933254$, I got 33°25′ 53·0″ and 9·9995576 as the geocentric latitude and the log. earth-radius corresponding to my observatory. With these constants, corrections of the moon's tabular places concluded from observations at Greenwich, and an

assumed longitude of 10h. 3m. 15·7s. E., I have discussed the twelve occultations. The following table exhibits certain data employed in the calculations and the resulting corrections of the assumed longitude :—

Day and Year of Observation.	Star observed.	Observatory Mean Solar Time of Disappearance.	Adopted App. Place of Star. R. A.	Adopted App. Place of Star. N. P. D.	Corrections to Moon's Tabular Places. R. A.	Corrections to Moon's Tabular Places. N. P. D.	S—c.	Resulting Correction to Longitude.
		h. m. s.	° ′ ″	° ′ ″	″	″	″	s
1866. April 18	B. A. C. 1468	6 14 36·2	69 36 56·0	71 30 46·8	− 0·6	0·0	+ 3·17	+ 6·37
October 15 ...	,, 6267	7 21 22·3	275 2 23·9	107 52 20·8	− 3·3	+ 2·6	+ 6·20	+ 12·78
1868. February 27	μ Piscium	7 48 46·9	20 48 51·9	84 32 24·2	− 0·9	− 0·7	+ 5·36	+ 10·04
March 2	m Tauri ...	10 11 27·2	74 54 49·7	71 32 14·8	+ 1·7	0·0	+ 4·62	+ 16·62
1869. February 17	ξ² Ceti	8 3 32·6	31 30 41·4	81 46 18·5	+ 0·5	+ 0·2	+ 5·31	+ 11·64
February 24	δ Cancri ...	8 0 49·8	129 18 47·9	71 22 7·1	− 1·2	+ 0·4	+ 1·14	+ 2·28
1870. February 11	ζ Tauri ...	8 18 1·5	82 28 11·4	68 56 26·7	− 1·8	+ 0·8	+ 1·77	+ 3·84
November 30	ψ Aquarii	10 7 52·2	347 16 38·1	99 47 33·5	− 3·0	− 0·4	+ 7·85	+ 15·70
1873. April 1	A′ Tauri ...	6 53 44·3	59 17 32·9	68 15 59·6	− 7·5	− 2·2	− 0·60	− 1·61
September 2	σ Sagittarii	13 27 17·2	281 51 27·9	116 27 12·2	− 7·8	− 2·2	+ 5·06	+ 10·12
1874. February 27	ψ Cancri ...	10 58 58·7	120 39 14·9	63 47 7·5	−10·7	+ 0·3	+ 4·97	+ 10·16
May 30	δ Scorpii...	11 36 34·9	238 13 48·2	112 15 58·1	− 8·4	− 3·5	+ 1·49	+ 2·79

The value $S—c$ in the eighth column of the table is the difference between the calculated apparent semi-diameter (S) of the moon and the calculated apparent distance (c) of the star from the moon's centre for the Observatory mean solar time of disappearance. Assuming that the only corrections required to the tabular elements are those of the moon's right ascension and north polar distance, the final equations give the corrections in the last column of the table. The moon's apparent right ascensions and north polar distances have been interpolated with second differences from the *Nautical Almanac* and the Greenwich corrections applied. I may mention that the occultation of *m* Tauri on March 2, 1868, is a very unfavourable one for the determination of the longitude, owing to its disappearance having taken place near the moon's northern limb. If, therefore, we reject the correction due to this observation, we have for the mean of the remaining eleven corrections, allowing equal weights to all, + 7·64s., and the longitude of my observatory becomes 10h. 3m. 23·34s. E.

It may also be well to state that the observation of the disappearance of ψ' Aquarii on November 30, 1870, was rendered uncertain owing to a passing cloud. It will be interesting for the sake of comparison to state here that I have compared fifty-three transits of the moon observed at Windsor with the hourly Ephemeris in the *Nautical Almanac*, corrected by means of the observations with the Washington transit circle. These transits were observed with the 2-inch transit instrument, fifty-one being of the first limb, and two of the second. The mean result for longitude is 10h. 3m. 21·58s. E., which agrees pretty well with that derived from the occultations. In May, 1865, a number of signals by electric telegraph were exchanged between the late Mr. Smalley and myself, in order to determine the difference of longitude between Sydney and Windsor. The result of this exchange of signals was that my observatory was 1m. 30·04s. west of that of Sydney. No regard, however, was paid to personal equation in this determination. If now we add this quantity to the corrected longitude of my observatory, as given in this paper, we have 10h. 4m. 53·38s. E. as the longitude of the Sydney Observatory. This value is greater by 7·64s. than that determined by the Rev. Mr. Scott from moon-culminations at Greenwich and Sydney.

I have a few other observed occultations of well-determined stars, both at disappearance and re-appearance, made since 1874, but the Greenwich corrections are not yet available. I trust at some future date to be enabled to turn these occultations to account, and also to obtain more trustworthy corrections of the tabular elements from a discussion of the meridian observations made at all the principal observatories during the semi-lunations in which the occultations have occurred.

In the meantime, I must express it as my opinion that the longitude of the Sydney Observatory, as given by Messrs. Scott and Stone, really requires a considerable positive correction. Before many years elapse, telegraphic communication will probably be so well established that we shall by that means be enabled to accomplish the accurate solution of the problem, just as in the case of Washington, whose longitude from Greenwich has been determined satisfactorily in this way within a second of time.

In conclusion, I may mention that I should have presented this paper to the last meeting of the Astronomical Section of the Society, but that I deemed it expedient to wait for the carrying out of a proposed exchange of telegraphic signals for a new and more trustworthy determination of the difference of longitude between Sydney and Windsor. Arrangements were made for an exchange of signals during the latter half of this week, but cloudy weather having set in the proposal has been frustrated for the present. I therefore deem it advisable to communicate the paper to the Council in time for their meeting on the 29th instant, in order to its approval for the General Meeting on the 5th proximo.

Windsor, May 25th, 1878.

The following supplementary paper, on the same subject, was forwarded by Mr. Tebbutt, and read at the meeting of the Astronomical Section of the Society, held on June 13th :—

On the 5th instant I read before the general monthly meeting of the Royal Society a paper on a correction to the assumed longitude of the Sydney Observatory, deduced from observations of lunar occultations of stars, made at my observatory, Windsor, in the years 1866-68-69-70-73-74. In that paper twelve occultations of well-determined stars were discussed, two of which were unfavourable for longitude results. One of these in particular was rejected, as having occurred near the moon's northern limb, and the resulting longitude of my observatory was made to depend on the eleven remaining occultations. This value is 10h. 3m. 23·34s. E. of Greenwich; and to it was added 1m. 30·04s., the difference of longitude between the Sydney Observatory and mine, as determined from telegraphic signals in May, 1865, giving 10h. 4m. 53·38s. E. as the concluded longitude of the former from Greenwich. Having reason to suspect that the telegraphic difference of longitude just stated was considerably too great, I requested the co-operation of Mr. Russell in a new and more accurate determination of the difference. This unfortunately could not be accomplished in time for the presentation of my paper to the Society. A new determination has now, however,

been made, and it fully confirms the suspicions which I had entertained respecting the old value. The following are the results from the recent exchange of signals :—

Mean of thirty-four signals sent from Sydney to Windsor	1m. 28·77s.
Ditto of forty ditto, Windsor to Sydney...	1m. 28·88s.
Mean of all	1m. 28·83s.

If now we reject both the unfavourable occultations referred to in my paper, and assign equal weights to the remaining ten results, we get the following :—

Assumed longitude of my observatory	10h. 3m. 15·70s.
Correction from the ten occultations ...	+ 6·84s.
Longitude of the Sydney Observatory east of mine	+ 1m. 28·83s.
Concluded longitude of the Sydney Observatory	10h. 4m. 51·37s.

This value exceeds by 0·56s. that obtained by Mr. Russell from moon-culminations observed by himself during the years 1863-71-72-73-74.

I trust, before the close of the present session of the Royal Society, to be in a position to discuss this question more completely. I have other occultations of well-determined stars, for which I yet require the corrections of the moon's tabular places. In the meantime I am desirous that these few remarks may be brought before the Astronomical Section of the Society, and regarded in the light of an appendix to my paper already referred to.

On the Meteorology of the Coast of New South Wales during the Winter Months, with the desirability of issuing cautionary storm warnings, by telegrams to the various ports, from the Observatory.

By Marshall Smith, Master of the ship "T. L. Hall."

[*Read before the Royal Society of N.S.W.*, 3 *July*, 1878.]

The periodical return of bad weather, of a most treacherous character, during our winter months—notably July, our worst storms in the past having occurred during that month, and which have generally caused more or less loss of life and property at sea—caused the writer to prepare this paper, with a view to elicit the views of those who may have better chances of procuring or compiling meteorological data, whether they are or are not preceded by certain atmospherical conditions and barometrical readings.

The writer's experience during six years as a shipmaster on this coast leads him to believe that the normal state of the weather is cyclonic; that is, areas of low pressure come up and follow each other quickly from the westward. The gales commencing in a northern quarter, veering with the sun's course through west and south-west, will blow hard for a time from the southern quarter, and gradually moderate, and, after a short spell of fine weather, again begin in the northern quarter, as another area of low pressure comes up from the westward. The barometrical conditions are, as we might expect, steep gradients on our coast; the lower readings being at our southern stations, the steepness of gradient between Newcastle and Eden, as a rule, denoting the strength or force of the coming gale. While the above conditions are in force, we have a continuance of comparatively fine weather, for these cyclonic winds bring very little rain with them, the clouds having probably parted with their vapour in passing over the high lands of the Australian continent. But nearly every winter we have a gale of an opposite character, namely, bad weather of an anti-cyclonic character, which comes up upon our coast from the eastward, bringing with it fierce gales, a heavy breaking sea, and a deluge of rain. These gales generally commence at some point between north-east and south-east, and they back against the sun's course more or less during the continuance of the gale.

In Knagg's Almanac we find that in July, 1866, the steamer "Cawarra" foundered, drowning all her crew save one, and fourteen coasters foundered or were driven on shore; and, again, in 1867, eight or nine more coasters followed. In July, 1876, the barques "Union," "Moneynick," and "Ann," with the whole of their respective crews, were lost, with several coasters; and in July, 1877, the "Yarra Yarra" foundered with the whole of her crew while endeavouring to re-enter the port of Newcastle.

The barometrical conditions preceding these storms (anti-cyclonic) we find in the storms of 1876 and 1877 to be of quite an opposite character, the barometer standing high at the various coast stations, and the gradients beginning to steepen in the reverse order, viz., the readings at the southern stations become the higher, and from observations of the barometer readings as given in the *Sydney Morning Herald*, the writer found that for some little time preceding the July gale of 1876, the barometer had been standing high at the different stations, with a steepness of gradient of about 20-100 of an inch between Newcastle and Eden, when then the gale burst upon us. Again, taking the gale of July last year, during which the "Yarra Yarra" foundered, the writer found that the barometer readings as given in the weather chart for Newcastle and Eden were as follows:—

	New-castle.	Eden.	Received in Observatory.	Published in chart.
Wednesday, July 11.........	30·43	30·56	July 11	July 12
Thursday, July 12	30·38	30·50	July 12	July 13
Friday, July 13...............	30·26	30 36	July 13	July 14
Saturday, July 14...........	30·10	30·30	July 14	July 16

From the above readings it may be seen that the readings had been very high at the coast stations for some time preceding the storm, and that on the Saturday morning (July 14) that the "Yarra Yarra" proceeded to sea, they were aware in the Observatory that gradients had steepened 10-100 of an inch between Newcastle and Eden—in itself a dangerous sign; and again, as in 1876, the difference between the readings at Newcastle and Eden was 20-100 of an inch, yet no cautionary storm-warning was issued from the Observatory that morning, or at least none was received in Newcastle, for had there been, the "Yarra Yarra" would probably have remained in port, and thus avoided her bad end. The inferences which the writer wishes to draw and place before the members of this Society for their free discussion (believing that by doing so he is best serving the cause of his fellow sailors) are:—1. That the normal state of the barometer during the winter months on the coast of New South Wales is low readings with steep gradients, the lowest readings being at the southern stations, with westerly winds of a cyclonic character and comparatively fine weather. 2. That when these barometrical conditions cease

to exist, and that instead of a set of low readings we find that—as in July, 1876 and 1877—the readings getting high at our coast stations, and the gradients beginning to steepen in the reverse order, I think we may fairly infer that an atmospherical disturbance of an anti-cyclonic character is threatening our coast, which may or may not reach our shores. 3. If the last inference is true (as the writer believes it is, and also believes that it is only by the careful study of meteorological data that this can be determined), but if it should be found to be so, then surely it would become our duty to urge upon the Government of New South Wales the necessity of issuing from the Observatory by telegraph to the various outports bad weather forecasts, when cautionary storm-warnings could be hoisted, and old and ill-found vessels would remain in port until the storm had passed over, or the atmospherical disturbance had passed away.

It may be said that the writer only gives the barometer readings preceding two gales, viz., those of July, 1876 and 1877, to substantiate this theory, and that this is not sufficient. In reply he can only say that they are the only ones; that he has been able (by being on the spot at the time) to look carefully over the weather reports, as during the gale of July, 1876, he was in Newcastle, and in July, 1877, he was off Wollongong, when the gale commenced, bound to Newcastle.

In conclusion, the writer would like to place before your notice the good that has been done on the coasts of Great Britain by the issuing of these storm warnings by the Meteorological Society, and the large percentage of successful warnings issued by them; and hopes that, by the careful study of data which we may possess, we may obtain some knowledge of fixed laws concerning these heavy storms which sweep upon our coast nearly every winter, and that warnings may be sent out, and the lives of our seamen be spared in the future; and as one of the means to this end, the writer would recommend the obtaining the logs of the vessels who may arrive after these gales are over, and most especially those vessels which may be *en route* to New South Wales from New Zealand ports, and so perhaps obtain information of their size, shape, and their progressive movement.

Discussion.

Mr. C. Stuart said: I consider that this is one of the most reliable papers upon this subject, or perhaps the only one we have had during this year. It shows the great value that nautical gentlemen set upon the observations from the Observatory. Although the writer is not a member of the Society, he hoped the paper would be considered of sufficient importance and sufficiently well written to be printed in our volumes at the end of the year. If it is necessary, I will move that the paper be printed.

The CHAIRMAN said this was not necessary. The printing of the papers read was a matter that rested with the Council.

Mr. KINLOCH asked what was meant by the steepness of the gradients, and coming in the reverse order. These storms interested him. Would Mr. Russell tell them if he had noticed the state of the atmosphere before these fierce south-east storms came on. He had generally been able to tell from the barometer and the state of the skin when they were coming on.

Mr. RUSSELL said: Mr. Marshall Smith has raised a most important question, and I wish he had said more about it. I felt rather disposed to shirk speaking about it to-night, because it is a long subject to go into, and would take about an hour to explain, on the assumption that there are members present who do not understand it. The writer of the paper really raises a wide question as to the character of the atmospheric disturbances on our coast. In England they have clearly made out the cyclonic character of the storms that pass over Great Britain. In New Zealand the character of the storms is very much the same; but in America they have quite a different state of things—the storms travel there in a different way. Now, in order to trace out the cyclonic storms, you want daily observations by telegram from a large number of stations, and since I have received such telegrams at the Observatory, I have learned to correct some ideas I had formed about our weather; one of these, viz., that our storms are similar to those in England—that is, that they are cyclonic—I had to give up. I am convinced that our storms are not cyclonic, in the ordinary sense of the term. Now in fine weather we generally get winds from the northern points; but if the barometer begins to fall in the summer, the wind gradually veers round to the westward, and thence to the south, the barometer indicating the approach of the southerly wind by a steady rise. As the polar wind comes in the loss of pressure is made up, and the wind dies out, and with a high (about 30 inches) barometer we have a return of fine weather. Such is the ordinary fine weather course of the wind. The weather telegrams have taught me this—that, for some reason which I am at a loss to explain, the barometric waves which pass rapidly across the surface of the earth in this country generally come from some point between south and south-west. A rising barometer on the south or south-west coast indicates that the barometer will soon rise here. The effect is that if one of these waves comes on rapidly, we have an increase of pressure on the southern coast which gives rise to a strong southerly wind. This represents what Mr. Smith speaks of as a gradient. If you will refer to the daily weather map you will see that these gradients frequently exist, but until they rise to 6 or 7 they are not dangerous; that is until the difference of barometers

for every 60 miles is 0·06 or 0·07; but here we seldom have anything of the sort. In the "Dandenong" storm there was a gradient, but there was nothing like circular motion in it. It came in from the south-west coast, followed up the Murray, across the mountains to Bathurst, and reached Sydney by the easterly motion of the atmosphere. I was able to trace its speed. It reached Sydney—(I am speaking just now from memory)—about 10 o'clock p.m.; it was at Newcastle about 1 o'clock a.m. and was met by one of the A.S.N. Co.'s steamers off the coast beyond Port Macquarie. I traced that storm in almost a straight line for nearly a thousand miles. So that it could not have been a cyclone. It is very evident to me that the bulk of our south-westerly storms come on in that way. The more important question which Mr. Smith raises is that of the easterly gales; and here I confess myself at a loss. I have studied them closely for some twenty years, and I am obliged to say that there is no satisfactory warning of them. I know that there is a certain sensation felt before these gales. There is an intense dampness of the atmosphere; but this often occurred and no gale followed. Within the last twelve months I have obtained some scraps of information which show that sometimes the south-east gale did not "blow home," as the sailors say. That is to say, a heavy sea could be seen off the coast, but it did not come right in, and while a south-easterly wind was blowing hard out at sea, the wind here was west. The cause which brings in the south-easterly gale was probably some decrease of pressure in the interior of the country; or probably from the demand of the trade winds. But there is really a great deal to be learned about it; and I would be afraid to predict the approach of a south-east wind. In nine cases out of ten they do not blow home. Sometimes the stations report a heavy sea on the coast, though the wind is light; but I know from the telegrams that the south-east gale is blowing overhead at the time. If such south-east winds off the coast had a little more force, they would come in and make destructive gales. The barometer was always high before these gales came on, and generally fell as they continued. I fully believe that something ought to be done in the way Mr. Smith suggests, but it cannot be said off-hand what is best to be done. I expect to get a good deal more information from the daily weather study about the gradients than I have hitherto obtained. We seldom or never get a gradient here that represents a south-east gale. It is found in England that if a moderate gradient continues in one direction for some days, the wind blows in that direction with considerable force—more so than if the gradient had existed for only a short time. I think the number of gales of wind of at all a serious character on this coast are small compared with those that prevail in New Zealand or the Mother Country. (Applause.)

Storms on the Coast of New South Wales.

By H. C. Russell, B.A., F.R.A.S., Government Astronomer.

[*Read before the Royal Society of N.S.W.*, 7 *August*, 1878.]

I purpose in this paper bringing under your notice the results of my observations upon the storms which pass over New South Wales. Before doing so, however, I should like to say a few words about some of the terms used in describing storms, and the sense in which I shall use them here. And first, what is a meteorological *gradient?* It is a term that has but recently been introduced, and is the expression for one of the atmospheric conditions, viz., a state in which if the pressure as shown by the barometer be examined along some line of country it will be found to increase or decrease gradually, as, for instance, when an area of low pressure exists it is found that the readings of barometers on lines radiating from its centre get gradually greater. It is not supposed that the atmosphere, like water, may have an inclination on its surface; but that it is in somewhat the same condition as a large mass of water heated more at one part than at another, and just as water in that condition would begin to move, the warmer flowing over the colder with a rapidity proportionate to the difference in temperature, so when a gradient exists in the atmosphere we have the condition which will produce motion, and the steeper the gradient the more rapid the motion. Various methods have been devised for expressing gradients. In England, a gradient is the difference in pressure expressed in hundredths of an inch of the barometer, between two places 60 miles apart: thus a gradient of 6 means that in 60 miles the pressure changes 0·06 in.; on the continent of Europe gradients are measured in millimètres instead of hundredths of an inch.

When the term is used here the English gradient is that understood. Now the experience in Europe amounts to this: that the force of wind will not exceed a fresh breeze, or 30 miles an hour, unless the gradient is higher than 6, so that a gradient along our coast would have to rise a difference in pressure between Sydney and Newcastle, for instance, of 0·06 before the wind would become strong from this cause, but there is another consideration which must always have weight when estimating the effect of gradients, and that is the *time* that they continue; for the bulk of the air to be set in motion is so great that it requires time to respond to small forces, and gradients frequently

exist between two places sufficient to produce gales, but before the air can be set in motion the wave of pressure passes on and removes the tendency to motion; and it is difficult in the ordinary atmospheric waves which pass over us to make allowances for this fact. At times when the wave is coming from the south a fresh breeze comes with it, but more frequently it passes with no appreciable effect upon our winds. Another difficulty is to estimate the effect of *changing* pressure at two stations, because it is impossible to tell how far the changes are going; a good illustration of this will be found in the "Dandenong" gale, of which more presently. On that day, with a southerly wind, barometer falling here and rising to south, a gale was inevitable, and warning might have been given had a system for such warnings been in existence, but the extreme force we experienced could not have been anticipated; the change in pressure was so rapid that the effect was like an impulse that doubled the velocity of the wind suddenly.

Another term which requires defining before I make use of it, is *cyclone.* By it I simply mean currents of wind moving in a generally circular direction, and *whirlwind* would be a better term, were it not that we generally confine it to cyclones of such small dimensions.

Two other words I should like to define, and then pass on to our subject: they are *tropical* and *polar.* By tropical currents or winds, I understand warm winds coming from any direction north of west and east, but generally between north and west; and by polar currents, any southerly wind (cold by comparison with the tropical) and most frequently from south-west, but the normal direction of which is south-east. Now, as you are doubtless aware, these two main currents are possessed by very opposite tendencies; that from the equator where it has gained the highest easterly velocity possible by the earth's rotation, comes to a higher latitude on its way south, and its easterly tendency is so much greater than the earth's surface motion there, that it becomes a north-west wind, or perhaps a strong westerly, while the polar current, coming from a higher latitude, has just the opposite tendency—that is, it moves towards west and north, or from south-east. But the tropical wind being by far the more abundant of the two, when meeting the polar wind generally deflects it, by the friction it exerts at the place of meeting, from its true course, and makes a south wind of it, and this action, aided by the form of the land (a long ridge of mountains) generally make our polar current *south-west.* It is obvious then that where these winds meet the direction will be a compound or resultant of the two, being westerly when they are equal, veering to north as the tropical gains force, and to south as the polar element increases, and being, when this has complete

mastery, south-east. Another important consideration in regard to the meeting of these winds is their extent. The meeting is not only at our point of observation, but extends many hundreds of miles east and west of us. Now, if from an extra heating at the equator, more than the usual amount of wind is sent south, what is to become of it at the meeting? Generally it finds vent in a strong west wind. Sometimes it drives back the polar current till the whole of Australia is in the tropical current and north-west winds are reported from the whole of south-east Australia; at Sydney by far the greater part of our time is spent in this dry (more or less) cloudless wind. But when the tropical wind loses power, the polar wind takes its place, and we then have south-west winds veering gradually to south-east, as they gain power, and I have known the south-east wind to blow over Sydney for several weeks. Now one circumstance which assists the incoming polar winds is the form of the country. A mountain chain stretching north and south, and rising to some 3,000 feet, obliges the north-west winds to rise to that extent, and so leave along our coast-line a way prepared for the incoming southerly wind, which comes rushing along our coast under the north-west wind and makes the plane of meeting of the two winds inclined to the surface, and in this meeting ground we have the most favourable conditions for the establishment of small cyclones, and some hill or other local cause frequently starts them into existence.

Turning now to consider the ordinary winds,

I have elsewhere ("Climate of New South Wales") briefly indicated the normal course of our winds, but with your permission I should like here to state again the general laws, because it is in the disturbance of these that we find our storms.

In summer our fine weather winds consist of the north-easterly by day (an indraft to the heated interior) and the light westerly off land winds at night, while over our heads is steadily blowing the north-west (that is, from N.W.) return trade wind, as may be traced by any upper clouds. The thickness of the local winds is generally under 4,000 feet, and the velocity seldom exceeds 40 miles per hour, while the overhead warm current generally travels some 80 miles per hour; such is the summer system which in fine weather is maintained sometimes for weeks. Now it will be admitted that an upper current such as I have indicated, and extending over all Australia and the trade winds to the east of it, is not easily deflected from its course; but if the sun's heat becomes greater at the tropics an extra demand is made upon the trade winds springing from these latitudes; and the barometer begins to fall, partly from the loss of air thus sustained, and partly from the greater amount of warm air which is present. Should the causes continue, the warm wind comes down to the

surface as the N.W. hot wind. In fact, a want of wind is produced in these latitudes by the action of the sun at the equator, and the N.W. wind, being as it were on the spot, is the first to come in and supply it, but it does not continue long, for the polar wind rushes in and being heavier naturally keeps the surface and lifts up the warm wind. It is this wedging underneath the warm wind that makes the peculiar roll of clouds that come with the southerly squall. With this inrush of cold heavy air the barometer rises rapidly, and the partial vacuum in the trades is supplied generally in a few hours, but at times it will blow hard from the south for days. The cause being thus removed, and the trade wind want supplied, the usual course of fine weather returns. If, however, the sun maintains its demand at the equator these inrushes of polar wind are frequent, and the regularity of the north-easters is disturbed.

There is still another form of disturbance resulting from excess in sun power, and it appears to come on in this way: If the sun be unusually powerful upon the interior it makes a sudden demand upon the supply of air for its up-current, our north-easter comes in with unusual force, and the southerly winds rush in from the south coast; these meet the warm tropical current, and give rise to thunderstorms which in many cases seem to be small cyclones. I do not like to be too positive about their character, for some of them seem to be so large that it is difficult to conceive of their passing over us with so little wind disturbance as they do. But with your permission I will refer to one storm that I brought under your notice last year, bearing upon this subject. The occasion for my doing so was, as you may remember, the passage of several remarkable thunderstorms over Sydney. The one to which I refer was on the 27th November, 1877. That morning was fine and very warm at Sydney; the temperature in the shade rose to 84·0, and the sun thermometer in black box showing the sun's heating power rose to 195·5. The barometer was falling and weather very hazy, showing the presence of the tropical hot wind nearer than usual, and a fresh sea breeze came in. The shade temperature inland was very great. At Bourke it rose to 113°. In Victoria and Adelaide a fresh S. to S.W. wind without any sea was blowing by 9 a.m. Such were the conditions that gave rise to the storm, that will long be remembered in the western districts. At Grenfell great damage was done to the houses by the violence of the wind, and at other places on the storm's track it proved most destructive. At noon the storm clouds could be seen in the west from Sydney, and at 5 p.m. a deluge of hail and rain broke over the city. While watching this storm I was struck by the long interval between flash and report, and found that one of the flashes seen nearly vertical was 8 seconds before the report; it was seen as it were

under the clouds. Other flashes were observed, not perpendicular, 10 seconds, 12 seconds, and so on. The storm clouds must therefore have had an altitude of at least 9,000 feet.

Now, taking the interval between the time at which the first streak of sky was seen in the west, and the time at which the end of the storm cloud passed over Sydney with an altitude of 9,000 feet, as shown, I found the storm was moving at least 50 miles per hour; and taking the time of its passing Grenfell and Sydney the velocity is found to be 68 miles per hour. Now these storm clouds must have been more than 200 miles in diameter, for when the storm was breaking over Grenfell at 5 p.m., 170 miles west, they obscured the sky at Sydney. But the most remarkable fact about this storm is its effect upon the barometer. At 6 o'clock, when the storm could be heard coming, the barometer suddenly began to rise, and in 20 minutes had risen 0·12 inch; and it is remarkable that in the middle of this rise it fell rapidly for 3 minutes and then began to rise again. (See copy of barograph sheet attached.) At 9·20, when the storm passed, an equally sudden *fall* set in for 20 minutes, and again a check came in the middle, and the barometer rose for 5 minutes and then fell equally fast. Now you will observe that from 6 p.m., when the rise began, to 9.40, the end of the fall, we have 3h. 40m., which is taking the determined rate of translation of the storm equal to 250 miles. Now, large as this will appear, I believe we have here a species of cyclone moving rapidly through the upper atmosphere with such force (68 miles per hour) that it increases the pressure in front of it, and causes a partial vacuum in its rear. I find by calculation that such a mass of clouds moving through the air at the rate stated would produce in front of them a pressure equal to 0·14 inch of barometer, and we have here a sudden rise of 0·12 inch after passing. A partial vacuum to the same amount would be left in the rear and would not be filled up quite so fast, as the front pressure would be distributed. Now we find here a fall of 0·15, and it took about an hour to recover itself. In fact if this view be correct, the storm cloud would be like a solid body moving through the air, giving rise to pressure in front of it as shown by the barometer and to a want of pressure in its wake which would be more gradually filled up; now if such a storm were formed in the upper air between, or in the meeting ground of the two main currents, its rotary velocity would be greater than that of its translation, and therefore sufficient to maintain its form. There can, I think, be no doubt about the velocity of its translation, and the explanation I have offered of the increase of pressure in front and the loss of it in the rear seems the most probable. It may be remarked that such a cyclone passing over us should disturb the surface air, and such was not

the fact, but it passed over so rapidly that there would not be time to get the heavier air in motion below it, impeded as such an effect would be by surface friction. And further, in proof that such cyclone storms are translated as I have supposed, it may be stated that it is a fact of common observation with regard to whirlwinds which pass along the surface rapidly, especially in the interior, and it was once my good fortune to see such storms in the meeting of tropical and polar wind in progress. When coming from Auckland to Sydney in October, 1875, the steamer's course brought us on the southern side of a series of such whirling storms that were travelling to the eastward; we passed through several smaller ones, which simply amounted on the surface to a squall of wind and a shower: but several of considerable size were in sight, and they presented the appearance of a mass of cumulus clouds rolled up, the sides being shaped like those of a funnel, but not coming to a point; they seemed very dense, as if a torrent of rain were falling there; the clouds did not reach the surface, and between the two well-defined sloping sides they seemed to curve upwards. These cyclones were probably two to three miles in diameter, and about $\frac{1}{4}$ of that in height; they progressed steadily to the east. Many similar storms recorded by the barograph might be brought forward had we time. The date of this great thunderstorm suggests a digression for which I have no time now, but may suggest in what direction it would lead me. I have found by the old records, that our most important thunderstorms have taken place in the latter half of November, and the earth as you know passes the great meteor stream on 13th and 14th of that month.

We have still another form of summer storm which is common enough in its milder forms, and at times rises to the danger pitch, but as it will be impossible within the limit of this paper to give many examples, I must select one or two that are typical and leave to your imagination or memories others that are of less consequence to us in tracing the causes of our storms.

This form is the summer easterly storm, commonly known as the black north-easter; that is, a strong N.E. wind, that blows continuously night and day for several days. The weather usually becomes cloudy as the storm proceeds, or perhaps is so when it begins, and very frequently rain falls. They are not so strong or so dangerous as the winter easterly gale, because the direction is generally inclined to the coast; so that a vessel can beat off, while the winter easterly blows from E. to S.E., fair on to the coast.

But to turn to the selected example. On the 17th February, 1873, with barometer at 30·01, weather very fine and N.E. breeze; 18th, barometer 30·12 very fine, N.E. breeze; 19th, barometer 29·98, hot and cloudy, N.E. breeze; 20th, barometer

29·90, fine, hot, N.E. breeze, thunderstorm in afternoon; 21st, barometer 29·9, very light S.S.E. and E.N.E. winds, steady rain in the afternoon; on 22nd, barometer 29·72 9 a.m., and 99·66 3 p.m., sea breeze E.N.E., thunderstorm and rain in the afternoon, and wind to south at night; on 23rd, barometer 29·74, cloudy day and thunderstorm at night. Now, so far, we have just a week of ordinary summer weather, except that the barometer had fallen; the southerly wind and rising barometer on 22nd seemed to betoken return of fine weather, but without any other warning a fresh N.E. wind sprang up in the night and by 9 a.m. of 24th was blowing 20 miles an hour and increased to 26 miles per hour during the day, with showers and dropping rain; barometer rose to 29·83, wind blowing fresh all the evening; and just after midnight of 24th, with no change in velocity and scarcely any in direction of wind only from E.N.E. to E.S.E., a perfect deluge of rain set in and the amount by 9 a.m. of 25th was 8·90, the greatest ever recorded in Sydney for one day; and the total number of miles of wind for the day was 494; after 9 a.m. of 25th the rain abated a little, but the wind increased and rose to 36 miles an hour, and the strongest gust rose to 83 miles, afternoon showery and very stormy-looking; barometer 29·82, and total rain for 25th 4·93; during the evening of 25th the wind abated, and by 2 a.m. the wind had changed to west, with fine weather. Fine weather—sea and land breezes followed with no noteworthy change in the barometer. Such is a violent summer N.E. storm; and one feels disposed to say whence came it, and whither did it go? for instruments tell one nothing. In this instance we have the storm with a low and rising barometer, and only a few weeks before we have a less severe but similar storm (21st November, 1872), with barometer at 30·04 and falling. Many of these storms clear up by change round to north and west, and others by change to south, so that there seems to be no rule which would help to find their source. The attached observations in New South Wales show weather and barometer changes similar to those at Sydney, but on turning to see the weather upon the the south coast, some light is thrown upon the cause, for at Melbourne a strong S.E. to S. wind was blowing; and I find upon examining a number of such storms, that almost invariably a strong S.E. to S. wind is blowing in Melbourne. Now this is a significant fact, for it points unmistakably to the cause of our N.E. gale, viz., the heated interior of Australia, which, by the up-current which it establishes draws in the wind on the south and east coasts. I have looked for observations in the centre of Australia to confirm this view, but unfortunately I find but few. Colonel Warburton, the explorer, happened to be camped near Alice Springs or as near the centre of Australia as possible, from December, 1872, to April, 1873, and he says, little or no rain fell during that time, and the temperature observations which he took

show that the weather was very hot all the time, but hottest in February; unfortunately he does not give the daily readings or the heat wave might have been traced. At Bourke we find a similar account of the weather, viz., very hot in February, especially from 16th to 22nd. Such readings as 106-109°, &c., in the shade, point to a sun power quite enough to require a good deal of wind from the south and east coasts to make up for the up-current it would set in motion.

Weather at Country Stations from 19th to 26th February, 1873:—

Thargomindah ...	19th, barometer falling till 24th, fell 0·40, gradual rise till end of month.
Armidale	Barometer very steady; wind E.; raining on 22nd and 24th; 3 inches recorded in the two days.
Bourke	Weather very hot during February; on 16th maximum shade 109°; 17th, 94°; 18th, 95°; 19th, 106°; 20th, 100°; 21st, 91°.
Port Macquarie	Wind W., went round to N.E. on 24th and E. on 25th; thick rainy weather after 19th, with frequent thunderstorms and a great deal of lightning.
Cassilis	Heavy thunderstorms; violent S.W. gale on 28th.
Scone	Very hot and oppressive, winds S.W.
Muswellbrook...	Heavy thunderstorms with rain from 20th till end of month; winds N.N.E. and N.E.
West Maitland	Fine till 21st, dull till 24th, raining rest of month; fresh E. winds.
Newcastle	Barometer steady, slight fall (0·30) till 23rd, then rose 0·10; fresh N.E. winds; raining after 22nd, stormy on 25th.
Orange	E. winds; heavy thunderstoms and rain.
Bathurst	Barometer fell gradually about 0·30 until 24th, then rose a little; fine weather; stormy on 25th; wind N.E. on 19th, S.E. on 25th, calm on other dates.
Kurrajong	Heavy thunderstorms and rain; wind N.E.
Mount Victoria	Barometer, slight fall till 22nd, then rose again; fine till 21st, heavy weather till end of month; calms and W. winds.
Woodford	Barometer, slight fall (0·30) till 23rd, rising again till end of month; wind on 19th N.E., 20th, W.; remaining days calm; heavy rains.
Parramatta	Thunderstorms with very heavy rain.

Weather at Country Stations—*continued.*

Liverpool ......Barometer fell 0·25 till 23rd, then went back again; wind W. till 21st, then E.; thunderstorms and very heavy rains; 10 in. in two days, viz., 25th and 26th.

Wentworth......Fresh S.W. winds; fine till 25th; stormy on 26th and till end of month.

Moss Vale ......Thunder and hail storms, heavy rains; 7 inches in one day (26th).

Goulburn ......Barometer fell about 0·30 till 23rd, then rose again; wind variable; thick rainy weather.

Terrara ....Thunderstorms on 20th and 23rd, 12·57 inches recorded on 26th.

Cape George... Barometer fell 0·30 between 19th and 22nd, and rose 0·25 between 22nd and 25th; N.E. wind prevalent; heavy rains and thunderstorms.

Lake George ...Barometer fell 0·30 till 23rd, then rose again, wind variable; heavy rains and thunderstorms.

Deniliquin ......Barometer falling 0·20 till 24th, rose again towards end of month; prevailing wind, S.E.; thunderstorms and squally after 3 p.m., 22nd.

Kiandra ....Barometer fell about 0·20 till 23rd, rose again gradually; E.S.E. and S.E. winds; heavy storm after the afternoon of 19th.

Albury............Barometer fell about 0.20 between 19th and 24th, then rose gradually; fine until 8 p.m., 23rd; storms and rain rest of month.

Cooma ....Winds E.; thunderstorms on 21st; rain till end of month.

Eden.............Barometer fell 0.22 between 19th and 23rd, and rose 0.20 between 23rd and 26th; wind S.W. on 20th, 21st, and 22nd, and E. on 24th, 25th, and 26th; dull 19th and 20th; thunderstorm from S.W. on 21st; heavy rains till end of month.

Melbourne.......Barometer 29·674 on Feb. 23rd, then rose to 29·804, and fell again on 26th, strong S.E. gale; 22nd to 26th inclusive, weather squally with rain.

Turning our attention now to the south-east storms in winter, which, from a commercial point of view, are the most important, because of their destructiveness, we remark that—

The general characteristics of a south-east storm are,—high barometer, great humidity, and rain; strong steady gale of wind from some point between S. and E., and very heavy sea, which

generally precedes the storm; they seldom last over three days, and in the majority of cases the dangerous part of the storm does not last two days. The velocity of the wind seldom exceeds 40 miles an hour; but the down-pour of rain seems to add force to the wind, and makes the air so thick that it is impossible to see any distance. In the very severe storms thunder, lightning, and hail come; but they are not by any means a necessary part of the storm. The danger of these storms lies in the direction of the wind blowing fair on the coast, and the very heavy sea which comes from the long stretch of ocean over which the wind blows. The most terrible wrecks on our coast have been in these storms, and they are limited (almost) to the months of June and July.

Erroneous opinions as to the cause of them, and the indications which mark their approach, have frequently been published; and I must confess that it is only a recent investigation into records of the Observatory which has made clear to my own mind what place we are to assign to our south-east storms. If, in the earlier part of this paper about the tropical and polar currents, I have made clear ordinary laws which govern the meeting of these two great wind currents, you will have no difficulty now in following out the history of a S.E. gale.

For this purpose, I have taken the anemometer and other self-registered results in the Observatory, and I find that since 1870 we have the following facts:—

During 1871 the westerly winds were very strong in the winter, and twice during July heavy gales from west, running up the daily number of miles to upwards of 570, took place, and we had *no easterly gale.*

In 1872 the winter was marked by still stronger westerly winds, which twice in June reached over 500, and in July reached 592 and 759 on separate days. These figures represent very heavy westerly gales, *and we had no easterly gale.*

In 1873 we find a very marked falling off in the force of the westerly winds; and in June, from 15th to 19th, we had an easterly gale, the greatest number of miles being on 16th, 539; the rainfall was not heavy, and the barometer standing at 30·21 on 14th, fell steadily to 29·689 on 19th. The humidity ranged from 96 on 15th to 89·3 on 19th, and fell to 64·7 on 20th. Reference to the tables will give fuller details. And in July this year, another moderate S.E. gale broke on the coast, bringing abundant rains. In this case, as in the one that preceded it in June, the wind had been between W.S.W. and S., when suddenly, about noon on July 24, it veered S.E. and increased in force; on the 25th it blew harder, with heavy rain and some hail; and on 26th it was clearing up. Here again we

have a high barometer, 30·200 on 23rd; but after falling to 30·176 on 24th, it rose steadily till the gale was over. The humidity was very high—100 on 23rd, 99·3 on 24th, 97·7 on 25th, and then suddenly down to 67·0 on 26th.

In 1874 westerly gales were very strong in the winter, running up the miles from 400 to 619 per day; and again we had no easterly gale.

1875. The early part of the winter the westerly winds were very light, and on the 5–6 of June a little easterly gale—if I may so express myself—set in, with barometer, on 5th, 30·196, falling steadily on 6th and following days. Humidity, 87·7, and rain very heavy; on 5th, 92; on 6th weather clearing at night; the miles of wind on 5th, 598; and on 6th, 524. Later in the winter the westerly winds gained force up to 500 and 659 miles per day, and we had no return of easterly gale.

In 1876 the westerly winds were strong only twice, the first time on June 16–17, and the second time, July 27–28–29; and during this winter S.E. winds blew home to the coast many times, and twice were remarkable, the first in June 25, 26, and 27, for the very heavy rain and high barometer 30·430, and the second on July 13th to 16th for the small amount of rain which fell, the barometer at its beginning stood at 30·153, rose to 30·295 on 15th, and then fell steadily as the wind backed to west, where the storm cleared up.

1877. In June this year westerly winds were strong, the daily number of miles being several times over 400, and on one day 590; but in July they seemed to have lost all force and in fact were very light, and as if it were only waiting the opportunity in rushed the S.E. gale, in which the ill-fated "Yarra Yarra" was lost. On the 14th July, 1877, the wind was W.S.W. to S.S.W., barometer 30·112 and falling, and between 7 and 8 p.m. the wind changed from S.W. to E.S.E. and began to blow fresh, increasing rapidly to 40 miles an hour with heavy rain; as the change in wind took place, there was thunder and lightning to S. and S.W.; on 15th barometer 30·00, blowing hard, very heavy rain with thunder and hail at half an hour after noon; at 6 p.m. on the 15th, the wind was blowing 46 miles per hour; but from that time it fell off and the wind backed to S.W. At Newcastle this gale was very severe, and the "Yarra Yarra" was lost there on the 15th (Sunday).

In 1878 you can all remember we have had unusually strong westerly winds, in June specially so; the daily register of velocity being frequently over 400 miles and twice over 720. In July the force was much less, but still it would seem too much for the S.E. wind.

Readings of instruments and anemometer records of these S.E. storms are given in the following tables:—

TABLE showing instrumental observations during S.E. gales.

Year.	Day.	Barometer.	Temperature.	Humidity.	Rain for 24 hours previous.	Remarks.
1873.	June 12 ..	30·080	59·0	99·3	0·972	
	13 ..	30·158	57·3	83·3	0·120	
	14 ..	30·214	54·0	88·7	0·000	
	15 ..	30·185	56·8	96·0	0·520	
	16 ..	30·150	63·8	94·3	1·650	
	17 ..	30·068	65·8	96·3	0·339	
	18 ..	29·969	66·8	94·3	0·021	
	19 ..	29·689	67·1	89·3	0·021	
	20 ..	29·819	58·0	64·7	0·080	
	21 ..	Rising.	53·6	71·0	0·000	
Painted walls very damp, water running down them 12th, 13th, 15th, and 16th; lightning E. and E.S.E. at 7·50 p.m. on 20th.						
1873.	July 19 ..	30·177	51·1	87·3	0·049	Raining.
	20 ..	30·199	52·1	97·0	1·570	,,
	21 ..	30·323	52·2	83·7	1·870	,,
	22 ..	30·276	51·0	99·3	0·420	,,
	23 ..	30·200	50·9	100·0	1·317	,,
	24 ..	30·176	52·4	99·3	1·085	,,
	25 ..	30·223	53·3	97·7	2·267	,, and hail.
	26 ..	30·291	53·2	67·0	2·111	Clearing.
	27 ..	30·223 Falling.	52·4	91·0	0·056	Fine.
1875.	June 3 ..	30·055	57·5	86·7	0·181	Fine.
	4 ..	30·220	57·2	95·0	0·000	Heavy clouds to south
	5 ..	30·196	57·2	87·7	0·446	Raining, stormy.
	6 ..	30·059	59·8	92·0	2·395	Raining, cleared about midnight.
	7 ..	29·952	57·5	80·3	1·765	Fine.
	8 ..	29·981	54·0	78·0	0·000	,,
1876.	June 24 ..	30·393	49·9	80·7	·000	Cloudy and cold.
	25 ..	30·430	51·2	100·0	0·286	Heavy rain.
	26 ..	30·318	54·9	98·0	1·725	Raining all day.
	27 ..	29·927	59·8	95·3	2·028	Raining.
	28 ..	29·971	54·3	71·3	0·214	Fine.
	July 12 ..	30·068	52·5	76·7	0·000	Fine.
	13 ..	30·154	52·3	92·3	0·010	Cloudy, cold rain.
	14 ..	30·261	53·9	71·7	1·675	Cloudy.
	15 ..	30·295	57·7	73·3	0·000	,,
	16 ..	30·103	58·6	87·0	0·010	,,
	17 ..	29·884	58·4	99·0	0·600	Raining.
	18 ..	29·971	56·9	86·7	0·425	,,
	19 ..	30·227	54·7	80·7	0·660	Clearing.
	20 ..	30·079	53·7	72·3	0·076	Fine.
1877.	July 11 ..	30·453	52·0	94·7	0·046	Raining.
	12 ..	30·418	51·7	99·0	1·088	,,
	13 ..	30·271	53·8	98·3	0·875	,,
	14 ..	30·112	54·6	94·0	1·538	,, lightning S.W. 8·3 p.m. thunder S. 8·42 p.m.
	15 ..	30·001	55·3	100·0	3·109	Heavy rain, thunder S., and hail at 12·30 p.m.
	16 ..	29·889	58·3	92·3	2·967	Raining.
	17 ..	29·774	57·7	94·3	0·356	Cloudy.
	18 ..	29·743	56·9	69·3	0·122	Fine.
	19 ..	29·826	52·2	67·0	0·000	,,

Direction of Wind, and Velocity (in

Date	9 am	10 am	11 am	12 am	1 pm	2 pm	3 pm	4 pm	5 pm	6 pm	7 pm	8 pm
June, 1873, 14	W 7	W 9	WNW 6	WNW 6	W 2	SSW 7	SSW 8	SSW 8	SSW 7	SSW 3	SSW 3	SW 4
15	SSE 19	SSE 16	SE 16	SSE 18	SE 23	SE 16	SE 12	SSE 15	SE 16	SE 16	ESE 11	ENE 14
16	E 20	E 19	ENE 27	ENE 27	ENE 26	ENE 30	ENE 25	ENE 21	ENE 23	ENE 19	ENE 23	ENE 21
17	NE 18	ENE 16	NE 24	NE 23	NE 22	NE 25	NE 29	NE 27	NE 24	NNE 24	NE 21	NE 26
18	NE 23	NNE 27	NNE 20	NE 20	NE 23	NE 26	NNE 23	NNE 17	NE 16	NE 15	NE 17	NE 21
19	NE —	NE 2	N 2	NNW 3	WNW 6	W 8	WNW 6	NW 5	NNW 9	NW 9	NW 14	NW 18
July, 1873, 23	S 5	S 9	SSW 6	W 7	SW 10	S 11	S 7	S 6	S 6	S 2	S 3	SSW 6
24	SW 3	WSW 3	S 11	SE 11	SSE 11	SSE 9	SSE 14	SSE 9	SSE 10	SSE 10	S 8	SE 10
25	SSW 7	SSW 9	SSW 6	SSE 8	S 5	S 11	SSE 12	SSE 3	ESE 12	SE 12	SE 11	SE 18
26	SE 24	SSE 27	SSE 26	SSE 24	SSE 25	SSE 24	SSE 23	SSE 18	SSE 18	SSE 19	SSE 18	SSE 17
June, 1875, 4	WNW 3	WNW 7	SSW 14	S 12	S 16	S 17	SSW 17	S 17	S. 12	S 12	SSW 6	SSW 1
5	ESE 27	SE 25	ESE 24	ESE 21	SE 25	ESE 26	SE 23	SE 26	SE 24	ESE 27	ESE 30	ESE 26
6	E 39	E 34	E 44	E 37	ENE 39	ENE 36	E 33	ENE 36	ENE 41	ENE 35	ENE 33	ENE 36
June, 1876, 25	NW 8	WSW 5	WNW 6	WSW 8	SW 9	SW 11	SSW 8	WNW 5	SW 9	SW 7	S 10	SSE 14
26	ESE 8	ESE 11	SE 8	ESE 11	E. 9	ESE 9	ESE 9	ESE 7	ESE 11	E 14	E 18	ESE 14
27	ENE 23	N 5	NW 5	N 12	NNW 9	N 8	N 5	N 2	N 2	NW 5	NW 3	NW 5
July, 1876, 13	W 12	W 9	W 14	SW 18	SW 18	WSW 9	W 9	W 14	SW 14	SSW 16	SSW 11	SSW 11
14	SE 18	SE 23	SE 23	SE 24	SE 23	SE 23	SE 20	SE 20	SE 27	SE 27	SE 27	SE 27
15	SE 32	SSE 27	SSE 27	SE 26	SE 24	SE 21	SE 24	SE 23	SE 23	ESE 27	SE 27	SE 23
16	SE 27	SSE 27	SSE 30	SE 27	SSE 27	SSE 28	SSE 26	SSE 24	SSE 26	SE 24	SE 21	SE 19
17	SSW 9	SSW 9	SSW 14	SSW 18	SW 18	SW 18	SSW 18	SSW 23	SSW 18	SW 14	WSW 14	WSW 16
July, 1877, 14	WSW 6	SW 14	SW 9	SW 11	SW 9	SW 18	SSW 16	SSW 11	S 16	SSW 9	SW 11	ESE 14
15	SSE 36	SSE 29	SSE 36	SSE 36	SSE 32	SSE 30	S 28	S 45	S 39	S 46	S 33	S 25
16	SSE 16	SSW 18	SSW 21	SSW 19	SSW 14	S 11	S 11	S 9	S 9	S 4	W 9	W 4

…gistering Anemometer.

in Italic figures), at each hour.

9 pm	10 pm	11 pm	12 pm	1 am	2 am	3 am	4 am	5 am	6 am	7 am	8 am	Mean
SW *7*	WSW *6*	W *4*	W *6*	W *2*	W *2*	SSW *4*	SSW *17*	S *17*	S *20*	S *14*	SSE *26*	SSW *195*
ESE *10*	E *15*	E *15*	E *18*	E *15*	E *18*	E *18*	E *18*	E *20*	E *16*	E *18*	E *20*	E *390*
ENE *18*	ENE *24*	ENE *18*	ENE *23*	ENE *20*	ENE *20*	ENE *26*	ENE *21*	ENE *24*	ENE *23*	NE *19*	ENE *23*	ENE *539*
NE *26*	NE *26*	NE *15*	NE *14*	ENE *14*	ENE *14*	NE *17*	NE *15*	ENE *14*	ENE *14*	NE *16*	NE *25*	NE *483*
NE *20*	NE *21*	NE *18*	NE *18*	NE *18*	NE *18*	NE *18*	NNE *14*	NNE *7*	NNE *8*	NE —	NE —	NE *406*
WNW *14*	W *14*	WNW *9*	WNW *11*	WSW *12*	W *11*	WSW *10*	WSW *23*	W *27*	WSW *32*	WSW *23*	W *14*	WSW *295*
SW *5* S *10* SE *16* SSE *14*	WSW *6* ESE *11* SE *16* SSE *15*	WSW *7* SE *16* SE *23* S *17*	W *3* SE *17* ESE *14* S *9*	WSW *5* SE *12* SE *23* SSE *7*	W *3* SSE *10* SE *25* W *7*	W *2* SSW *11* SE *23* WNW *6*	S *5* SSW *9* SE *20* WNW *7*	SSE *9* SSW *11* SE *23* WNW *6*	SE *9* SSW *9* SE *27* W *6*	SSW *6* SE *9* SE *23* W *8*	SSW *8* S *11* SE *25* W *8*	S *144* SSE *248* SE *369* SSE *368*
SSW *9* ESE *25* WNW *18*	SSW *1* ESE *19* W *10*	SSW *2* ESE *17* W *10*	SSW *1* ESE *18* SW *10*	SSW *3* ESE *21* WSW *5*	SSW *1* ESE *19* WSW *3*	SSW *1* ESE *23* WSW *2*	SSW *0* ESE *27* W *5*	ESE *12* E *27* W *6*	ESE *20* E *32* WNW *2*	ESE *27* E *33* WNW *5*	ESE *27* E. *36* WNW *7*	SSW *231* ESE *598* ENE *524*
SSE *16* E *18* NW *11*	SSE *18* E *20* W *11*	ESE *16* E *20* W *11*	ESE *11* ENE *18* WNW *18*	ESE *12* ENE *20* WNW *9*	ESE *10* NE *8* WNW *2*	ENE *18* ENE *17* NW *11*	ENE *11* ENE *14* NW *9*	ENE *11* ENE *12* NW *9*	SE *14* NE *9* NW *9*	SE *11* NE *2* NW *3*	SE *9* NE *3* WNW *10*	ESE *255* ESE *290* NW *197*
SSW *16* ESE *27* SE *23* SE *18* SW *16*	S *17* ESE *27* SE *27* SE *18* SW *17*	S *17* SE *26* SE *23* SSE *18* SSW *24*	S *16* SE *28* SE *27* S *14* SSW *27*	SSE *19* SE *27* SE *27* S *14* SSW *28*	SE *20* SE *27* SE *30* S *14* SSW *32*	SSE *19* SE *27* SE *28* S *11* SW *27*	ESE *18* SE *26* SE *27* S *11* SW *32*	ESE *13* SE *28* SE *27* S *9* SW *27*	ESE *15* SE *27* SE *27* S *10* SW *26*	SE *14* SE *32* SE *23* SSW *8* SW *24*	SE *18* SE *27* SE *24* SSW *9* SSW *26*	W *354* SE *609* SE *617* SSE *459* SSW *489*
SE *23*	SSE *23*	S *23*	S *23*	SSE *32*	SSE *27*	SSE *32*	SSE *32*	SSE *32*	SSE *36*	S *41*	SSE *36*	SSE *498*
S *19*	S *11*	S *7*	SW *8*	WSW *2*	SW *8*	SSW *12*	S *14*	S *15*	S *18*	S *18*	S *16*	S *568*
W *7*	WSW *4*	WSW *7*	WSW *7*	WSW *7*	WSW *11*	WSW *9*	WSW *7*	W *9*	W *9*	W *10*	W *10*	W *243*

The weather at the end of last month (July, 1878) affords such a good example of the course of winds and changes which lead on to a S.E. gale that we may spend a few moments in following them.

On 24th July barometer stood at 30·03, cloudy and cold, with westerly winds.

On 25th, barometer 29·96; wind and weather similar, barometer unsteady and falling fast.

On 26th, barometer fallen to 29·64; cloudy with warm W.N.W. wind blowing fresh; and the weather map shows that on the south coast, where N.W. winds had prevailed, a change to S.W. had set in—in South Australia and Portland—and indications of change appeared at Wentworth, where weather looked stormy.

On 27th, wind had veered to W. here, blowing fresh and cold; at Sydney barometer low and unsteady, and between 2 and 5 p.m. one of those peculiar markings which I suppose to show the passage of a cyclone is recorded with something like a faint repetition of it between 9·30 and midnight; at 3h. 7m. p.m. there were a few drops of rain, weather very cloudy. In Victoria, 3 p.m., weather wet and squally; wind south, 48 miles an hour. Barometer risen to 29·68; barometers to south rising; weather wet and squally, with heavy sea on the south coast; barometers very low at Sydney and along the coast south of it.

28th, strong cold W. to W.S.W. wind; barometer 29·89, and generally rising fast.

29th, S. to S.W. winds generally on the weather map; barometers all from 30·10 to 30·30; very heavy sea reported at Gabo, and heavy as far as Cape George. By a letter from Mr. Thomas Hale, at Bulli, I was informed that this sea began on Sunday morning (28th) with a heavy quick swell from S.E.—heavy-looking clouds in east—rollers making up a mile from the shore in 7 fathoms. On 29th the S.E. sea did not follow along the coast, but missed Sydney and Newcastle, and at 3 p.m. was reported at Port Macquarie. Note to foot of weather map stated that there was S.E. gale off the coast.

30th, barometers all high, 30·30 to 30·40; winds between south and west; very heavy sea along the coast from S.E., but still not home at Sydney, and did not get home here until 4 p.m.; easterly winds reported on the high lands, but by no station on the coast; it was evident thet S.E. wind was blowing overhead, and the sea only was coming home.

On 31st, barometers nearly the same; heavy sea on the coast; winds westerly, and weather seems to be clearing. During the day barometer fell fast, and at 3 p.m. smooth sea at Cape George, Sydney, and Newcastle—still heavy to north and south—looks as if the easterly gale was nearly over; but a very rapid fall of pressure was going on at Sydney, and places west of it to Forbes—

becoming more rapid after 11 p.m., and by midnight a light easterly wind with rain had set in, and looked very like the gale coming home On 31st, from Clarence River to Cape George wind had changed to N.E. to E. with rain. Still heavy sea in places. At Sydney the morning looked very dirty, and barometer fell 0·18 by 12·30 p.m., when a terrific shower of rain came on. 1 inch fell in 6 minutes, and the weather cleared up from west.

On August 1st and 2nd, the wind got round to west again, and the weather cleared up.

Now, we have in this period just the ordinary changes of wind which lead on to a S.E. gale, and the gale was evidently blowing hard off the land, but did not come home; and I believe the single reason why it did not is that the westerly wind had more power, and kept it in check, as it were, so that it spent its force to the east of us, for during the recent storms the miles of wind on 26th was 615, on 27th 720, and on 28th 601; and in all the examples given of easterly gales which have blown home (see tables herewith) we have seen that the westerly winds have always been light. Now, my experience of the weather here, and especially since the weather map has been published, which places before us day by day a general view of the weather, is that easterly gales frequently blow in the offing, sending a heavy sea home; while along the coast the S.E. wind is not felt at all, but it shows itself high up on the mountains, sometimes far inland, and on the south coast. Now, in the recent storms which I have described (July, 1878) you will observe that the wind veers round from west by south-west and south to east. Now, this is the normal way for the wind to veer here. Our north-west wind is tropical; the west — compound of north-west and south-west—is generally with us a low barometer wind, proving that we are generally in the light or tropical part of the current; and as the wind veers to south the barometer rises to its maximum; and when the wind reaches south-east, that is in the unadulterated polar current, it is highest. Here the polar current is generally from south-west, being changed in direction by the prevalent westerly winds. Now, when a disturbance takes place, if it is to the east of us the westerly winds blow over here in full force, and the south-west and west winds come in and supply the want. If, however, the disturbance be west of us, or from some cause the tropical wind be wanting in its usual force, then the polar wind takes its true direction and blows on our coast as the dangerous south-east gale. The facts from *self-registered*, and therefore unbiased observations, which I have brought under your notice, are very significant. Year after year, with strong westerly (tropical) winds, we see nothing of the polar (south-east) current; but in the same series we have seen that if the westerly fails in force then the south-east gale comes in. Should

further investigation bear out these results, as I have no doubt it will, the south-east gale is shorn of one of its dangers, for we shall know when to expect it. Of what might be called the immediate indications it is more difficult to speak. The safest guide I think is to be found in the sea and the clouds to south and south-east. The barometer, as you will see by looking at the results given, sometimes rises and at others falls, is at one gale 30·430, and at another 30·101; and the humidity varies from 73 to 100, so that barometer and thermometer are not much use. Now, you will doubtless have noticed that I have confined this investigation to the past seven years. I have done so because during that period the records of the Observatory have been sufficiently complete to enable me to trace out the storms completely in the short time devoted to this paper. There are however two historical S.E. gales of which I should like to say a few words. The first is that in which the "Dunbar" was wrecked, on 20th August, 1857. On 18th, barometer stood at 30·131, wind variable; on 19th, barometer 30·270, cloudy, wind S. to S.S.E.; on 20th, 30·020, heavy rains and blowing a heavy gale from E.S.E. to E.N.E.; on 21st, barometer had fallen to 29·750, S.E. to S. wind; on 23rd, the wind was south, weather clearing. Now during this winter (1857), the westerly winds were almost absent here, and the S.E. wind came home frequently. During June 15th, 16th, and 17th, there was a heavy storm from S.E., with torrents of rain; barometer 30·192 on 15th, and falling as the gale blew itself out back by south into fine weather. Again in July of the same year, on 21st, with barometer at 30·188, wind changed to S.E. on 22nd; barometer had risen to 30·199, and it then gradually fell as the wind backed into S.W. on 25th; on 26th the wind was again in S.E., barometer falling; torrents of rain fell on 27th, wind E. to E.N.E., heavy gales and floods. Barometer 29·966 on 28th, barometer rose to 33·062, wind S.E., clearing; 29th, 30·115, S.E., clearing. So that it appears that during this winter when westerly winds were almost absent, there were three heavy easterly gales.

The other gale to which I referred, was that known as the "Cawarra" gale, perhaps the most disastrous ever known on this coast. In the winter of this year, also, the westerly winds were very light, and at times altogether absent for days together; in May, E. to N.E. winds were frequent, and in June there were two light S.E. gales and rain; the first began on the 11th, with barometer 30·619, the velocity only from 15 to 20 miles an hour and the rain light. The second began on 18th, with barometer 30·400, moderate rains fell, and the wind was not strong, in fact although these two have all the characteristics of S.E. storms, they did not rise in force to gales. In July however the storm was severe, preceded as usual by light winds from W. and S.W.,

the barometer gradually rose to 30·249. On the 9th of July, 1866, a light N.W. wind was blowing, the day was fine with light southerly winds; at 9 p.m. it was overcast, with rain-like clouds; on the 10th, barometer 30·282, light westerly winds a.m., light S. in afternoon, and light west at night, cloudy, but clearing towards night, but at 6·45 p.m. lightning was observed in a bank of clouds low down in S.S.E. On the 11th, barometer 30·210 and falling, wind westerly, in the morning weather fine; about one o'clock p.m. the wind began to veer from N. through west to S., and by 2·30 p.m. was blowing from S.E. a light breeze of only four miles an hour, but it steadily increased hour by hour; weather was cloudy, and at 5·45 p.m. lightning began in S.S.E. and spread all over the heavens as the storm clouds came upon us; by 9 p.m. the wind was blowing 21 miles an hour; it was then raining and continued to do so all night, with increasing wind, which by 6 a.m. of 12th had risen to 40 miles an hour, with gusts of from 50 to 60 miles an hour; rain fell in torrents and there was a heavy sea all day of 12th; it blew hard, 30 to 40 miles an hour, during the day, the strongest gust being 56 miles per hour; meantime the barometer was falling and stood at 30·036, after 9 p.m. the wind very gradually backed to S.S.E., and the velocity began to fall, and by 9 a.m. of 13th it was S. only 25 miles an hour; the barometer rose a little, 30·073, and the weather cleared with falling barometer on 14th.

Several obvious and important conclusions come from these examples. 1st, we may never expect a dangerous easterly gale if the westerly winds are in full force in the winter. 2nd, the easterly gale comes on with the wind veering round from W. through S. 3rd, when the barometer is very high, 30·400 and upwards, the gale is not strong. The heavy gales come on with barometer about 30·200, and are accompanied by thunder and lightning usually. 4th, as the barometer falls, the gale clears up by *backing* to S., and it rarely returns to S.E., but clears up at once by returning westerly wind.

We have another kind of winter storm which may be dismissed with very few words, as it seldom is dangerous to shipping and is so gradual and well marked in its approach that no careful observer will be caught unprepared. I allude to the westerly gales, which, excepting those from S.S.W., to S., are the strongest we get, but blowing as they do right off the land, it is only when vessels are on the way from New Zealand here that they become serious. The strong west winds of these latitudes are well known, and the simple reason, it would seem, why they at times blow so hard is that an extra supply of tropical current has come down with its great initial velocity, which, as I have shown, amounts in the upper currents to 80 miles an hour. A little extra force then in the circulation within the tropics will give us a westerly gale.

' I have one other variety of storm to place before you, if you will have patience with me for a few minutes longer. It is that variety which brings us the most furious storms, but fortunately for us the direction S.W. to S. is not such a dangerous one for shipping as that of the S.E. gale. In this class we must place the "Dandenong" gale, and as I was at considerable trouble to work out the history of that gale, I have chosen it as an illustration of the variety of storm we have now to consider. They are caused by the polar wind rushing northwards, and being accelerated by some local cause they are often made more severe by the passage of one of those barometric waves from the south which so frequently pass over us. Should one of these arrive on the south coast when the S.S.W. wind is blowing, it seems to give it new force and send the wind forward. If indeed we are not here confusing cause and effect, which I am very much disposed to believe; for there must be a continual oscillation between the two currents tropical and polar; when the former prevails, pressure falls, and when the latter pressure increases, by the weight of the wind as well as its velocity, and such an impulse in an elastic fluid must go forward even if the air does not go with it. On the 7th September, pressure was falling along the south coast, and the lowest barometer (29·460) is recorded at Hobart Town, at 4·30 p.m. on the 8th; on both these days, but especially on the 8th, all the observations taken in the four Colonies, South Australia, Victoria, Tasmania, and New South Wales, show that a strong tropical current from N.W. was blowing all over South-eastern Australia. In New South Wales all the barometers stood at about 30 inches, and the weather was very hot; this warm wind extended to the southern point of Tasmania during the morning, and the humidity at Hobart Town was down to 64.

BAROMETER readings during the "Dandenong" gale, September, 1876.

Time, 9 a.m.	9th.	10th.	11th.	12th.
Melbourne, for 91 feet above sea...	29·892	30·190	30·031	29·736
Adelaide	30·015	30·242	30·046	29·657
Deniliquin	29·899	......	30·111	29·973
Albury	29·877	......	30·002	29·926
Eden	29·847	29·883	30·119	29·930
Cape St. George	29·846	29·586	29·742	29·833
Goulburn	29·955	......	29·971	29·935
Bathurst	29·961	......	29·859	29·862
Forbes	30·503	30·025	29·837	29·857
Sydney	29·942	29·652	29·710	29·714
Newcastle	29·986	29·583	29·528	29·721
Armidale	29·956	......	30·038	29·933
Port Macquarie	30·060	29·672	29·382	29·604

The first note of the change to polar wind comes from the "Agnes Jessie," then on her way from Hobart Town to Melbourne. She started on the 3rd September, had N.W. winds till 5th, and thence to 8th, fresh W.N.W. to the 8th, when it shifted to S.W. and blew hard until her arrival in Melbourne on the 9th. Between noon and 3 p.m. of the 8th September, at Adelaide, the wind changed suddenly to S.W., and at Portland the same change is reported at 3 p.m. At Tasmania it had not taken place at 4·30 p.m., but is reported next morning at 7·30, and wind south.

During the night of the 8th the battle between the two currents was going on, and at 9 a.m. of September 9th the polar current had made considerable progress. We find on reference to map 1 that it was blowing at Adelaide, Portland, Melbourne, Wentworth, Balranald, Hay, Deniliquin, Parkes, and Forbes; that is, it had made its way under the tropical current by following along the rivers or low lands in Riverina and up the Lachlan River; except the S.W. corner, all other parts of New South Wales were at that time involved in the tropical hot wind. Another tongue of the S.W. wind was making its way along the coast to the east of the Dividing Range, and reached Eden at 4 a.m. on the 9th, and by 9 a.m. the whole district from Kiandra to Eden was involved in thunderstorms, which marked the meeting of the two currents. That morning (9th), the "City of Hobart" was coming round Cape Howe, had fine weather and N.W. winds, and about 4 a.m., when off Merimbula, the wind suddenly shifted to south, and the weather looked very bad to S.E. S. wind and heavy sea followed the "City of Hobart" all day and until 5 a.m. of the 10th, when she ran into the westerly wind then blowing over Sydney. At Moruya the wind changed to S. at 6 p.m. of 9th. The "Gleaner" schooner, from Albany, New Zealand, to Melbourne, and about half-way on her voyage, after continued head winds, had, on September 9th, a sudden change to S.E. about noon, and the wind blew with almost hurricane violence. The schooner "Louise," from Newcastle to Warnamboul, met a S.E. gale at 6 p.m. on the 9th. "You Yangs," from Sydney to Melbourne, left at 4 p.m. 6th, northerly winds to Gabo 7 p.m. 7th, thence to Rain Head fresh N.W. winds, and then a sudden shift to S.E., wind blew with almost hurricane violence for eighteen hours, with high cross sea, passed Wilson's Promontory 7 p.m. on 9th September. "Hero," left Sydney for Melbourne 1 a.m., September 9th, had northerly winds to the Pigeon-house, then changed to S.S.E., and gradually increased to a heavy gale, ship hove to fourteen hours, light winds thence to Cape Liptrap, thence N.E. winds, passed Wilson's Promontory 1 p.m., 11th September.

It is worthy of note here that, at 9 a.m. on September 9th, when as we have seen the S.W. wind was blowing along the low lands from Portland to Forbes, a N.W. wind was blowing at

Urana and Albury, showing that the N.W. was then blowing over a narrow tongue of S.W. wind. At 9 a.m., Orange and Bathurst were still in N.W. wind, but at the latter place the change was visible like a thunderstorm in S.W., and at 10·15 a.m. the storm and change burst 12 miles north of Bathurst. Upon the road to Hill End, where a friend of mine was going, there was much thunder and great disturbance, but between 11 a.m. and noon they were out of it, and again in the N.W. hot wind. Arrived at Hill End, terrific storm and change of wind broke over the town at 4 p.m. The first storm at Sydney that evening was at 6 p.m., and assuming, as is probable, that this was the first storm mentioned near Bathurst, carried east the still powerful N.W. current, it represents a motion of translation for the storm of 15 miles per hour, and as it passed over Sydney there was a sudden rise in the barometer, and a fall in its rear, similar to those noted earlier in this paper. All the 9th September the barometer at Sydney was falling fast, and the heavy rains inland were evidently increasing the partial vacuum and helping the polar wind. Map No. 2 shows the state of the weather at 3 p.m. on 9th. Thunderstorms and rain extended from Parkes to the sea, showing the meeting of the two currents, and the S.W. wind was blowing generally S. of this line.

The barometer continued all that night to fall rapidly at Sydney, and along the south coast it was rising fast. During the night, that is, at 12·40 a.m. of the 10th September, the wind at Sydney veered to S.W., but got back again into the old quarter (west) by 3 a.m., at 9 a.m. it began to blow fresh from W.N.W. Unlike as the direction may look, this was really polar wind that was blowing over Sydney from W.N.W., for the temperature had fallen from 76.5 on 9th to 55.2, and all day of the 10th the wind at Sydney continued from W.N.W. to W.S.W.

Map No. 3 is intended to show, first, the state of the weather at 9 a.m. of the 10th, and second the observations of the vessels off the coast. You will observe that the S.W. wind had found its way to the west of the mountains as far north as Narrabri, and along the coast as far as Bodalla, while at Sydney, Newcastle, Musclebrook, and Scone, the westerly wind was still blowing, and in Queensland N. to W. winds, while at Adelaide the polar current had already changed to its true direction, S.E. At sea the "City of Melbourne," then off Cape George at 10 a.m. of 10th, met the S.E. gale, which blew furiously all day. At Moruya a terrific gale from S.S.W. set in at 10 a.m., and this had been preceded by a thunderstorm at 4 a.m. The steamer "Boomerang" (Rockhampton to Sydney), was off Smoky Cape at 10·30 a.m., and she there met a strong southerly breeze, which lasted only a few hours, and the wind backed to the west again.

The southerly was only a puff of the coming storm, and it is interesting because it shows how difficult it was to displace the tropical current.

During the forenoon of the 10th, snow in some places three feet thick was lying on most of the western slopes of the Dividing Range, proving how fresh the polar current was from cold regions, when it could make snow within a few hours of a hot wind (for on the morning of the 9th, the same country had been covered with a hot wind). The change had begun 3 p.m. on 8th, at Portland, and did not reach Sydney till afternoon of 10th, or progressed about 13 miles an hour, while the wind velocity was 50, and the difference represents the work done in displacing the tropical current.

We have thus traced the polar current from Portland to Smoky Cape, a distance of 1,000 miles in a straight line, in fact the S.W. wind kept steadily on, following what is evidently the line of least resistance for this wind; and the air being once in motion in that direction, was ready to receive any impulse that might be given to it in the same direction, and such an impulse in the form of one of those waves of pressure from S. was then coming up, and the barometers on the south coast were responding by a rapid rise, while that at Sydney was still falling. At 9 a.m. the barometer at Melbourne read 30·198, at Adelaide 30·242, and at Sydney it was down to 29·652, which shows that there was a gradient of 6 between Melbourne and Sydney, and this acting all day upon wind already in motion, had a very decided effect, the more so as the barometer got still lower on the coast north of us, and the "Boomerang" reports the barometer down to 29·30 at 3 a.m. of 11th, when the violent squall struck her. At this time the barometer at Sydney read 29·593, which is a gradient of 16, which is quite enough to account for the squall passing on so furiously. I have already mentioned that a furious squall struck the "City of Melbourne" at 10 a.m. of 10th, and the "City of Hobart" at noon, and the "Royal Duke" coming through Bass's Straits at noon on 9th. At Sydney the gale burst upon us in all its fury at 9·50 p.m. of 10th, wind S.S.W., 68 miles an hour, all night it blew at an average rate of 57 miles per hour, and between 12·18 and 12·30, or in 12 minutes, 22½ miles of wind passed the Observatory, that is at the rate of 112 miles per hour, and in one short gust at 12·30, the velocity rose to 153 miles per hour, equal to 117 lbs. pressure on the square foot. It must however be borne in mind that this was not on the surface of the ground. The anemometer is 65 feet above the top of the hill on which the Observatory stands, where the wind has full play, and I have frequently found the velocity of wind near the surface 50 per cent. less than where the instrument is. Now following the squall north, it reached Newcastle

at 1 a.m., "Governor Blackall," 18 miles off Newcastle, 2 a.m. At Morpeth, the night watchman on the steamer's wharf reported that there was a shock of earthquake between 1 and 2 a.m., that lifted the steamer "Collaroy," and made a rumbling noise, at the same time it disturbed the water very much. The squall reached the "Boomerang" at Seal Rocks, at 3 a.m.

At the Clarence and Richmond Rivers as well as in Queensland no such gale is reported. At the Tweed River it was blowing strong from N. and West, and in the afternoon of the 11th September veered to S.W. The schooner "Noumea" coming from New Caledonia in latitude 30° met the S.W. gale on the 10th, but this was probably only the first puff—he says nothing of the furious gale; and the "City of San Francisco" reports that on the 11th of September he had strong winds from N.N.W. with heavy sea, and wind veering to N.W., barometer falling gradually till it reached 29·32; the captain determined the steamer to be on the moderate or eastern side of a cyclone, distant from its centre about 180 miles; wind continued to veer to west and moderated; passed Lord Howe's Island at noon on 12th, wind now W.S.W.; during the night of the 12th had violent squalls of wind and rain, with heavy topping sea from southward and westward. The above is the "City's" report as she passed Lord Howe's Island at noon on the 12th. It is evident from her report, those from Queensland and our northern ports, that the S. W. gale did not extend much further than we have traced it, and the captain was in error when he thought that there was a cyclone to west of him, for the "Noumea" schooner was about 180 miles west of him and saw nothing of it. The truth was he was passing from the tropical into the polar current, and the wind veered in a normal way from N. round by W. to S.

It is worthy of remark that the first puff of the storm passed over Sydney twenty hours before the main storm, and over the "Boomerang" seventeen hours before; so that this puff was moving in the same direction, but slower than the great storm. It is seldom that such a gale as the one we have been considering offers any satisfactory means of determining its rate of progress, but the violent squall was not to be mistaken; and though observers generally forget to give the time of changes, this one, however, was so marked, that they have in this case given the times. Now, if we here repeat these times and see the rate of progress, we get some valuable results, which show that the actual progress of such a storm over the surface is by no means the same as the velocity of the wind. In fact, that the wind in displacing another uses up in so doing its own velocity.

Storm reached			
Sydney at 9·50 p.m.	Newcastle, 60 miles, 1 a.m.	=	20 miles per hour.
" "	"Boomerang," 100 miles, 3 am.	=	20 "
" "	"Governor Blackall," 2 a.m.	=	19 "

or the storm's rate of motion is 20 miles an hour. In the earlier part of its progress it only made 13 miles per hour, but then it had to make its way uphill and overcome the surface friction as well as the opposing N.W. current, but having passed the mountains and got on the coast its progress was more rapid.

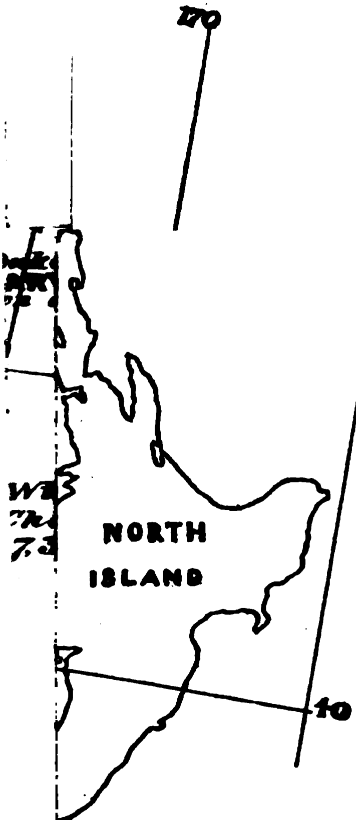
That this storm was not a cyclone is evident from many facts I have placed before you, but if anything more is wanted, it may be found in the report of the steamer "Llewellyn," from Auckland to Sydney. She left Auckland 4 p.m. of 9th, and had light head winds to the 11th, when she was met by a furious westerly gale that lasted all the way to Sydney. At the same time then, that a violent S.S.W. gale was blowing along our coast, there was blowing *over* it the strong westerly gale that began 4 a.m. of the 10th, and which was lifted up by the polar current.

No better example than this storm could be selected to show how the polar winds at times displace the tropical ones. Without waiting to draw conclusions from what we have seen, I would like to call your attention to one which explains a common phenomenon on the coast, viz., the S.E. sea when the wind has been from S.W. In this storm you saw that the polar current, where free to move, came in from S.E. past the "Gleaner" schooner and others; as a S.E. gale bringing a very heavy sea on to the coast, at the very time a furious S.W. wind was blowing on the land. This is the ordinary course—only the sea comes home.

If in what I have said it has been made clear to you how the polar current found its way north, you will see at once that the ordinary southerly burster is just the same wind in character as this dangerous storm, and that it gets in by following the land along the mountains where the tropical current is most easily displaced. No doubt the "Dandenong" storm was remarkable, but it was one of the ordinary changes from tropical to polar current, accelerated by the circumstances then occurring in the waves of pressure, &c. Now these changes do not come without warning, and the system of weather telegrams now in use gives us in the weather map ample warning of their approach, but whether the change will be violent or not can only be ascertained by a careful study of the forces at work at the time.

I have omitted much that I should like to have added to these remarks, but I have already far exceeded the bounds usually set to a paper of this kind, and I will not longer trespass upon your time.

[Four maps.]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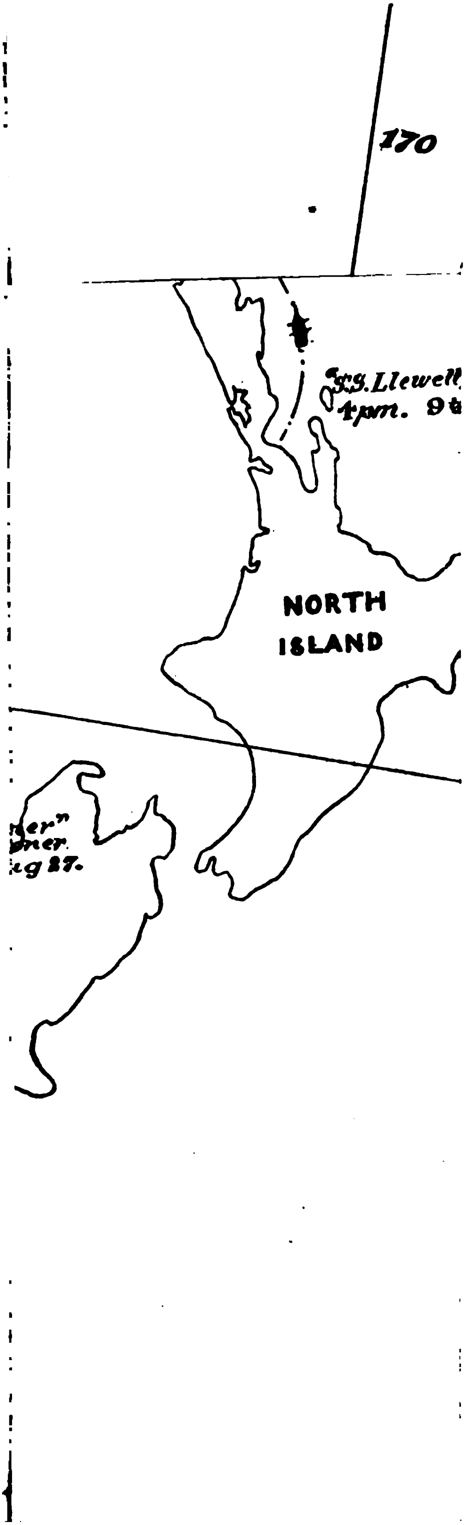

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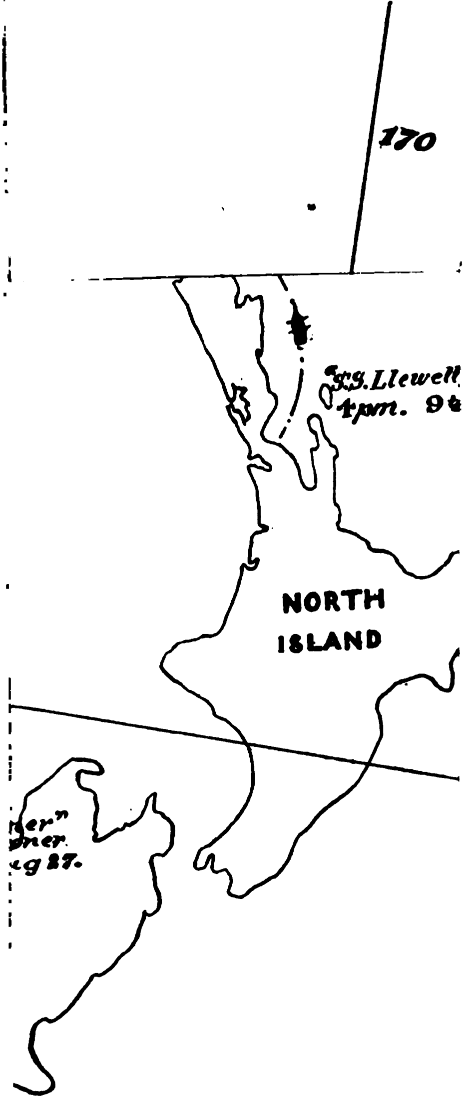
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Discussion.

Captain Trouton said:—It may be naturally expected from me as a seaman, and one who has been intimately connected with the shipping, and consequently has had knowledge of the winds prevailing on this coast, to make some remarks on the very admirable and useful paper read to you by my friend Mr. Russell. But it would require a very clever head to gather up all the figures and matters referred to in indication of the winds, and properly criticise them at this hour of the night. But there were one or two remarks that just struck me in passing, that I think would require future consideration. One was his description of the gradients of the barometer. Mr. Russell, from his position at the Observatory, has referred to the fact that mariners have a great source of advantage now in knowing the course of the winds on the coming day. I must differ from Mr. Russell there, because a mariner navigating a ship is not aware, as we are here, of the recorded winds on various parts of the continent. Of course a commander that was 250 miles off Sydney would not be aware of the south-west wind blowing about South Australia, or through Bass's Straits, that is indicated to us daily on the map. The data, therefore, from which he draws his conclusions is wanting to make the knowledge practically useful to those whom it most concerns; and it requires that some one should be appointed by the Government to watch over this matter and give this knowledge to navigators on the coast, so that they might know what was likely to be the wind blowing. (Hear, hear.) As a navigator on this coast for many years, I have given this subject my careful study, and I have since given it much study from a stationary position. Occupying the position I do, I watch the weather very closely, for I should not like to send out one of the vessels of which I have charge, with some 200 or 300 passengers on board, to meet the fate of the "Cawarra" and other vessels. But the result of all my observations is, that I have failed to be able to indicate the weather of the following day. I may tell you that some of the travelling public had perceived my weakness of being a little weatherwise. One old gentleman, now no longer with us, used to say, "Well, captain, how is the weather going to be to-morrow?" Well, I would say, "I think it will be so and so." "I will bet you a bottle of champagne it will not," he would say. And I can assure you I lost more bottles of champagne than ever he paid me. Although I had so long an experience on the coast, I have to confess I know very little about the weather likely to come on the following day. Since then, I have watched a barometer in my desk, and recorded its indications three times a day. Well, I have seen the barometer standing steadily at the same range during excessive changes in

the weather as in beautiful fine set weather. Whether I am in as good a position sheltered by the hill as Mr. Russell is in on the hill I do not know, but I believe Mr. Russell is free to confess he even cannot now tell what weather we are going to have to-morrow. There is another observation I caught as Mr. Russell read his paper,—it was with regard to the black north-easter, "we know not where it comes from, nor whence it goes." I would point my friend's attention to where I think it goes. It does not extend south of Cape St. George. I think that these black north-easters fringe on our hills, striking off them into eddying winds. Many of the travelling public, not mariners only, between here and Victoria, must have frequently seen how ships coming up from the south in the summer with topsails set, as they get off Cape St. George, are invariably taken aback by the north-easterly. It is only a matter of a few minutes. This north-easterly wind very rarely works its way further than Cape St. George; I cannot say where exactly it comes from, but it always comes at exact right angles with the south-east trade wind, even when blowing at the strongest. But it is the south-easters that we ought to look out for, with a view to warn mariners of their coming; and I think it my friend looked through the telegraph wire to New Zealand, he would get a better indication of the south-easter coming on our coast than by looking anywhere else. The principle he has laid down for seeking the cause of this south-east trade is very beautiful, but I do not think it is very useful to the mariner at sea. My own experience—and I have written to the papers some ten years ago on the subject—is, that when there is a strong westerly current through Bass's Straits, there is a strong set northerly on to our south-east coast. It certainly throws a swell on to the coast; and in all the vessels I have navigated I found, after passing through the Straits with a westerly current, and turning Wilson's Promontory, that there was south-easterly weather setting in to the 90-mile Beach or on to the Ram Head, as was clearly indicated by the compasses. It was owing to this current that I think the unfortunate loss of the "Auckland" was due. You will remember that one of the Melbourne Steamship Company's boats was close in beside her; both vessels were running the same course, relying on their compasses, when they found themselves in the bight. And this occurred in just such weather as I have stated. The dangerous winds for us are the south-easters, and I think as we have now a wire to New Zealand, we must look there for their source; I feel we shall get more information from there than in relying on the direction of the wind on our own continent. With regard to the seas that break on our coast, Mr. Russell observes that some come truly home and others do not. This may possibly arise from the fact that the gale in the distance does not come home. But there is this,

I think, that you should bear in mind,—that fresh westerly winds through Bass's Straits will throw a very strong southerly wave up this coast; that you will particularly see at Bateman's Bay, where although there may be a west or a west-south-west wind blowing, a heavy sea will be running in. I regard this as one of the most valuable papers that have been read before the Society, but it cannot be fairly discussed to-night.

Some Facts about the Great Tidal Wave, May, 1877.

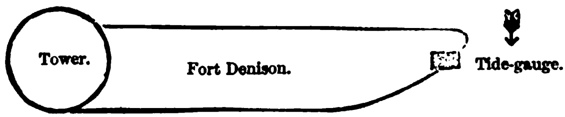
By J. P. Josephson, C.E.

[*Read before the Royal Society of N.S.W.*, 4 *December*, 1878.]

This tidal wave was observed at the following places, viz., Sydney Harbour, Newcastle Harbour, Ballina, Richmond River, (in N.S.W.), Brisbane (Queensland), Napier, Wellington, Christchurch, Akaroa, Omaru, Kaitangata, Lyttleton, and many other ports and bays in New Zealand, Sandwich Islands, South America.

Sydney Harbour.—The gauge is fixed at Fort Denison. The tidal wave of the harbour marked on diagram made its appearance on the gauge at 5·20 a.m. on the 11th of May, 1877, and the oscillations gradually increased to a maximum of 42 inches, and on the 13th they died away. The average interval was 34 minutes.

I may mention that the float of the gauge at Fort Denison is placed in a well, and a tube, 6 inches diameter, is connected to it from the harbour to let the water in; diameter of well, 3 feet 6 inches, but may perhaps be partly stopped with seaweed; the gauge could not record the full force of the wave; it came up the harbour almost at right angles to it. (See sketch.)



There are two tides in Sydney Harbour regularly every day; the extreme range from the extreme highest tide to the extreme lowest is 6 feet 9 inches; and the range of low water, or difference between lowest spring-tide and lowest neap-tide, is 2 feet 1 inch, while the average difference for the year through between these tides is only 1 foot, and the average difference between high and low water is 3 feet 4 inches. (*Russell—Climate, N.S.W.*)

The establishment of the port is 8 hours 38 minutes.

The entrance to the harbour is between two headlands, which are called the North and South Heads, distance apart being about 1¼ mile. When entering them, no doubt the wave got partly broken, and then having to fill several large bays, and cross the bar, the full strength got lost before reaching the gauge, which is fixed about 3 miles up harbour from the heads.

Note.—A man was cleaning a yacht in the harbour, when suddenly the water rushed upon him, which he recorded about 3 feet 6 inches. The "Boomerang" steamer, 655 tons, was being taken on the A.S.N. Co.'s slip, at noon, when one of the waves came in, and lifted her suddenly off the cradle, and then receding, left her high and dry.

It may be within the memory of some that between the 15th and 20th August, 1868, a succession of waves reached Sydney, and were recorded by the self-registering tide-gauge. The average interval between the waves was about 25 minutes, and the greatest oscillation 34 inches, measuring from the crest of one wave to the hollow of the next. It was thought at the time that they were earthquake phenomena.

A similar visitation reached us again in August, 1873, but it was not so marked in its character. The self-registering tide-gauge shows that the disturbance began during the afternoon of the 15th, and attained its maximum between 1 a.m. and 4 a.m. of the 17th; the greatest oscillation, amounting to 5 inches, occurred between 3·15 a.m. and 3·33 a.m. of the 17th; the average interval of the waves at this time was 25 minutes; but the average of 20 between 8 p.m. and 5·30 a.m., was 28 minutes. The waves could not be traced beyond the 18th. (See *Nature*, Oct., 1873.)

Newcastle Harbour, situated about 60 miles north of Sydney. The tidal wave made its appearance on gauge (shown by a full line on diagram) at 5·20 a.m. (same as Sydney) on the 11th May, 1877. At the greatest oscillations the water fell 31 inches in about 10 minutes, after which the oscillations gradually died away. The average interval between the waves is about 22 minutes; the greatest oscillation, 31 inches. The float of gauge is fixed in a well, the sides of which are formed of ballast; an ordinary wave washes in and out freely. This port has a bar across the heads, which no doubt helped to break the waves before they reached the gauge.

Ballina, situated about 320 miles north of Sydney Heads. This place was also visited with a similar phenomenon; it was observed all day; greatest rise, 18 inches. No gauge there to obtain information.

Brisbane.—Several tidal disturbances have been observed in Moreton Bay. No gauge there for information.

I have no records of these waves from the Southern Colonies.

There are two tide-gauges in Sydney Harbour—one at Fort Denison, and the other at Fitzroy Dock, Cockatoo Island, about four (4) miles westward of the other—and one in Newcastle. Night and day are distinguished on the diagrams by a shading of the hours which belong to night, viz., the space from 6 p.m. till 6 a.m.

The waves, as shown on the diagrams, appear as a succession of abrupt upheavals of the surface, and they have lost every trace of resemblance to the true form of the natural wave, although for engineering purposes, arguments, and reference, the outline in the diagram is correct. (This arises from the difference in the horizontal and vertical scales of diagram.)

On diagram I have shown the rise and fall of the surface of the harbour due to the tidal wave from the Pacific Ocean.

TABLE showing the highest and lowest points displayed by the Tidal Wave on the 11th, 12th, and 13th May, 1877.

Date.	Time.	Highest point.	Lowest point.	Remarks.
		′ ″	′ ″	
11 May ...	6·40 a.m.	5 7¼	......	Sydney; dotted line.
" " ...	6·40 "	5 5	......	Newcastle; full line, N.W.
" " ...	1 p.m.	......	2 2¼	Sydney.
" " ...	1·45 a.m.	......	0 10¾	Newcastle.
" " ...	8 p.m.	6 5¼	......	Sydney.
" " ...	6·37 "	6 5	......	Newcastle; westerly wind.
12 " ...	1·35 a.m.	......	2 1	Sydney.
" " ...	1·20 "	......	1 1¼	Newcastle.
" " ...	7·35 "	5 6	......	Sydney.
" " ...	8 "	5 4	......	Newcastle; N.W.
" " ...	1·40 p.m.	......	2 1½	Sydney.
" " ...	1·5 "	......	1 5	Newcastle.
" " ...	7·30 "	6 10¼	......	Sydney.
" " ...	8·5 "	6 7	......	Newcastle; S.W.
13 " ...	2·30 a.m.	......	1 11	Sydney.
" " ...	2·45 "	......	1 3	Newcastle.

NEW ZEALAND.

Telegrams from New Zealand report similar waves on the east coast from 5 a.m., extending from the Bluff to Poverty Bay. The greatest range was 6 feet, the least 2 feet. It would therefore appear that the waves came from the S.E, as they are not reported from the west coast of New Zealand. It is unfortunate that the exact time they reached there is not given; but it is evident they have come over the thousands of miles in a very short time, and must be similar to the earthquake waves which reached our coast in August, 1868.

On 11th May a remarkable fluctuation of the tide occurred, and attracted a good deal of attention. The pulsation of old ocean was in fact quite abnormal, indicating a restlessness that has not been noticeable here since the so termed tidal wave of 1868. This time a disturbance in the waters of the harbour was first remarked about daybreak by fishermen in pursuit of their calling about the banks. The tide was observed to rapidly recede, and then as suddenly to flow several feet up the banks. An hour or two afterwards a person of Mansford Bay was astonished to observe the water rapidly ebb away far below spring tide low-water-mark, exposing the lower part of his slip, which had not been laid bare since the disturbance of 1868. About 9 o'clock a strange tidal turmoil was noticed at the pier of the Quarantine Island. First the tide ebbed, it being then about low-water, and then it flowed, and so continued rising and falling from 7 inches

to 18 inches. The tide pulsations were very apparent up and down, and that, too, with a strong flood tide running—the rise sometimes being as much as 15 inches to 20 inches in half as many minutes, whilst the ebb was nearly as great. This action and reaction stirred the harbour to its depths, and rendered the water quite turbid, whilst the vessels at anchor in the stream were slewed about by the changing tide—and once the tide, then being strong flood, took quite a half cant to ebb. This was particularly noticed by a person who happened to be afloat at the time. He also timed and measured one of the pulsations, and found the rise to be quite 15 inches in about eight (8) minutes, whilst the recoil was about 9 inches in a similar time. A tidal disturbance was also noticed at the Heads. The pilot said that a strong ebb tide was running at Hobart Town Point, whilst the vessels at anchor and the lightship were swung at flood. He thought it was caused by the heavy sea on the bar. From this it would seem that the fluctuations were not closely observed at the Heads, which is to be regretted, as they would doubtless have been more decided there.

Napier, 11th.—A special telegram states that there was a great tidal disturbance all through last night at Gisborne. This morning, at 2·45, at ¾ ebb tide, the tidal wave came over the bay, and rose 8 feet above the top of the hull of the "Go-a-head." The men to save their own lives had to fly to the rigging. The wave struck the bar partially and broke; it nevertheless caused a sudden rise in the river of from 3 to 4 feet, overflowing the banks on the low-lying portions. At 9·30 the second and a heavy wave ran up the river, causing great alarm. At 9·45 there was another, and almost immediately afterwards a fourth. The weather was fine, with a fresh breeze blowing, and the water in the bay was much agitated.

Wellington, 11th.—Since before 8 o'clock this morning a tidal wave was noticed, its rise and fall being about 4 feet, and the action and reaction occupying about 15 minutes. It is still going on, but increasing. At the reclamation works, where the water is confined to an incompleted breastwork, the tide rushed in and out with a force resembling the tide at the French Pass.

Christchurch, 11th.—There was a strange tidal disturbance this morning in Lyttleton Harbour. From 7 till 1 o'clock the water has been rising and falling in an unusual manner, at times rising 3 feet in a few minutes, and falling equally rapidly. No damage has been done. It was felt at Waimakariri also, and at Timaru.

Akaroa, 11th.—A heavy tidal wave was experienced here this morning, first at 7 o'clock, when it was nearly dead low, water. The sea came in with great force and receded in 5 minutes, the rise and fall being about 8 feet. The waves are coming in at intervals of about 20 minutes. No damage is reported.

Omaru, 11th.—A curious tidal phenomena was experienced here to-day at low-water (about 8 a.m.). The water in the bay rose in about 10 minutes until within 1 foot of high-water-mark. This continued with more or less variation till noon, when a tidal wave came rushing into the bay. A barque broke away from her mooring warps at the breakwater, and being caught in a strong current and whirlpool was dashed against the inside of the breakwater, and then washed towards the shore, where she struck the bottom. Under the able seamanship of the harbour-master she got clear and put to sea. Through striking the bottom she commenced to leak, and an hour after she put to sea she had made a foot of water. The other vessels at the wharf were only slightly damaged about the rigging, through colliding with one another.

Kaitangata, 11th.—At 10 o'clock this morning a wave about 18 inches in height was seen coming up the river, carrying all small pieces of driftwood, &c., with it, against the current and strong S.W. wind. The river rose 4 feet above its former height, but receded within 20 minutes. This swelling had continued hourly up till 2 p.m.

Lyttleton, 11th.—The effects of the tidal-wave were much felt in Pigeon Bay. The water rose 12 inches above o.h.w. mark, covering the handrail of the wharf.

From a private letter received from Port Charters (New Zealand, Auckland) I collected the following information:—

Friday, 11th instant, we had a tidal wave that washed from 200 to 300 logs which were down at the mill up the creek.

The tide kept rushing in and out all day. It rose and fell on an average about 8 feet in every 20 minutes, sometimes as much as 10 or 12 feet in that time.

Once, about 2 p.m., it rose and fell more than the first time. A punt was anchored in Reef Bay. She parted her chains and went on shore. The wharf is a good deal twisted, but none of it carried away.

A powerful steamer, while crossing Cook's Straits, encountered a very heavy tidal wave. The stern dipped under water, and the vessel was drawn back about ½ a mile.

Off New Zealand Coast.—Cruise of H.M.S. "Sappho."—H.M.S. "Sappho" arrived at Auckland on May 26th. She was caught in a violent squall a few days before, which blew away all her sails and hove her on her beam ends. She lay in a very dangerous position for a few minutes, but afterwards righted. The "Sappho," after leaving Samoa, went through Hapu and Tonga Groups, searching for the schooner "May Queen," supposed to have disappeared when the earthquake was felt at Tonga, but without success. It was also experienced very strongly at Vavao. There were ten or twelve rises and falls at Vavao on 11th May,

the greatest rise being about 10 feet. The reef was left quite exposed at times, and as the water receded it left millions of fish behind it on the rocks. The effects were very extraordinary. The natives do not recollect anything like it, and they are in a great rage—accused the "Sappho" of bringing the wave. At Tonga the wave lifted the stranded ketch "Pearl" right off the reef, and left her in deep water, saving a lot of trouble and expense.

A huge Wave.—On the passage of the Union Company's steamer "Taranaki" across Cook's Straits on the 25th May (the *Otago Daily Times* reports) a huge tidal or blind wave struck her fair abeam, poured in volumes over bridge and decks, filled the main-deck rail-high, lifted the after starboard bridge boat out of the chocks, and dashed it upon the engine-room skylight, and, passing over, swept both the post-bridge boats away, wrenched one of the iron davits out of the brackets, and carried away all the bridge-rail on the port side. The main body of the sea swept over the poop, carrying with it the after skylight, the brass head of the capstan, the wheel and everything appertaining to it, excepting the bare iron stearing gear; all the taffrail and starboard quarter-rail, with the netting of course, and as the quarter-rail went it wrenched away a section of the covering board. The force of the sea also burst in four dead-lights of the saloon cabins, splintering the thick glass, and in the case of one of them drove the fragments right across the cabin into the wooden jalousie partition, fracturing the woodwork. When the after skylight went, tons of water poured into the saloon, flooding it over 2 feet deep on the lee side. For a minute or so after the sea struck her the "Taranaki" lay like a log in the water, and no wonder, weighted as she was with a flooded main deck, but, as good fortune ordered, the poop gave way, and through the openings thus formed the water discharged itself, and the steamer was once more free and buoyant. It is a remarkable thing that not one life was lost over it.

Sandwich Island.

The Tidal Wave at Sandwich Island.—At various places on the coast of the Sandwich Island great disturbances of the tide (which was felt on the distant coast on 11th May last) were observed, but at Hilo the disturbance appears to have reached its maximum.

The tidal wave struck the group of islands on the 10th May, between 4 and 5 a.m. The sea suddenly receded, and returned with great violence in a wave 16 feet high, which entered the harbour of Hilo, and swept away the wharf and storehouses in front part of the town.

We are informed by the Honolulu papers that there the difference between the highest and lowest water-mark was 36 feet, and that it rose 13½ feet above half-tide mark. It was the severest ocean wave experienced at the Sandwich Islands since 1837. The destruction at Hilo may thus be summed up:—Seventeen people drowned, thirty-seven dwelling-houses entirely destroyed, and seventeen badly injured, 163 people left destitute without homes; the total damage done at this port is estimated at £3,000. Although Hilo has suffered the worst of all the Hawaiian ports, the above record of loss gives some idea of the aggregate loss the kingdom has sustained.

It is remarked by the *Hawaiian Gazette*, that though the volcano Kilane had been active about that time, there had been no earthquakes there, and it was concluded that the upheaval of the coast had occurred on the west coast of South America. A captain who had arrived from Samoa has given some information respecting the earthquake wave at Upolo, Navigator's Group. He states that the wave was felt at 3·30 a.m. on the 11th May, and from that time the water washed out and into the harbour until 3 o'clock in the afternoon. Sometimes the harbour seemed to be empty. There was not much damage done.

South America.

Losses by Tidal Wave.—Panama, June 9th. Losses by tidal wave are fully up to first reports. The Government is a heavy loser, from 40,000 to 50,000 tons of guano having been lost. June 17th.—The *Chilian Times* of May 16th, reports that south of Valparaiso there was no loss of life or destruction of property by the earthquake between Valparaiso and the Bolivian frontier. Shocks were more severe at Autredcfagasta, in Bolivia. No lives were lost, but the damage to property is estimated at 500,000 dollars. It is said that the towns of Celama, Chinchia, and San Pedro have entirely disappeared.

On May 12th a telegram from London stated that the town of Iquique, on the Peruvian coast, had been destroyed by an earthquake. Iquique is a sea-port town in the department of Arequipa, Peru, and near the port is an island famed for its guano deposits.

Subsequent news told us that the earthquake took place on May 9th, and on July 6th a London telegram said the damage done amounted to 20,000,000 dollars, equal about £4,000,000.

The distance between Sydney and Iquique is about 7,000 miles.

The *Liverpool Albion*, 26th May, says:—"The tidal wave which lately caused so much destruction at Iquique extended its ravages to other portions of the western coast of South America, and a telegram from Valparaiso announces the total destruction of no less than seventeen vessels on the Peruvian coast, whilst forty more have been more or less seriously damaged. Of those

lost fifteen are known to have been laden with guáno; and it is probable the remaining two were. The total loss of property is estimated at nearly £300,000. The following are the names of the vessels lost laden with guano, viz.:—

Loaded at Pabellon de Pica.	The "Alida," an American ship.
	The "Drot," a Norwegian ship.
	The "E. F. Gabain," a Dutch ship.
	The "Lady Belleau," an English barque.
	The "Uncle Toby," an American ship.
	The "Lancashire Witch," an English ship.
	The "Geneva," an American ship.
	The "Courier de Lima," a French barque.
	The "R. B. Chapman," an English barque.
	The "Shamrock," an English ship.
	"Coquimbo."
Loaded at Huanillos.	The "Avonmore," an English ship.
	The "Conference," an English ship.
	The "Conway Castle," an English ship.

The Earthquake in South America and Great Tidal Wave.

Town destroyed and 600 *lives lost.*—"*The Star and Herald*" of Panama, received to-day, June 17, has details of the disaster and destruction caused on the South Pacific coast by the earthquake and tidal wave of May 9th. The towns of Arica, Iquique, Ponta, Delabos, Isabellon, Depica, Chanavaya, Huanillos, Copilla, Cobija, Mijillones, De Boliva, Antopagasta, and Chanarabal, are nearly destroyed. About 600 lives were lost. The destruction of Paballoa is estimated at £5,000,000. The destruction was confined mostly to the coast, although the town of Tarapaca 23 miles inward, and the villages of Pocomattalia and Conejonas, far in the interior, were more or less ruined. The shipping of guano from the southern deposits will be indefinitely suspended, as all facilities in the way of launches, chutes, wharves, water-condensers, and buildings of all kinds have been swept away. The destruction of and damage to the shipping have been very great, and attended by very serious loss of life.

At Mollendo the railway was torn up by the sea 300 feet, and at Ilo the railway was also injured. At Arica the people were preparing temporary fortifications to repel the threatened assault of the rebel ram "Huascar," the moment when the roar of an earthquake was heard.

The shocks were very numerous and caused immense damage. The sea was suddenly perceived to recede from the beach, and a wave from 10 to 15 feet feet high rolled upon the shore, carrying all before it. Eight times was repeated this assault of the ocean,

and 4 miles of embankment of the railway melted away like sand; locomotives, cars, and rails, were hustled about like so many playthings, and left in a tumbled mass of rubbish.

The United States Steamer "Wateree," stranded in 1868, was lifted bodily, and floated half-a-mile north of her old position. A cable buoy was moved a quarter of a mile northward. Merchandise from the Custom-house and stores were carried away 5 miles distant. The damage done was greater than that of the calamity of 1868. It has levelled the Custom-house, railway station, submarine cable office, hotel, British Consulate, steamship agency, and many private dwellings. Thieves began to rob, when the troops fired upon them, killing and wounding several.

Destruction of Iquique.

Iquique was built of wood, and tumbled down at the first onset. Lamps were broken, and the burning oil, spreading over the *débris*, started a general conflagration. Three companies of firemen were instantly at their posts, although it was difficult to maintain an upright position, shock following shock with dreadful regularity. To procure water, the two best fire-engines were stationed at the beach. Just then the cry arose—"The sea, the sea!" and the waves rushed in; the engines were carried away by the reflux, and the fire continued unsuppressed. Three elements of destruction were busy at one moment—fire, water, and earthquake. The affrighted people left the city to its fate, flying to the neighbouring eminences. The fire destroyed a large portion of the town, the earthquake levelled nearly all the rest, and the water covers ruins which it took out in its reflux. The water condensers along the shore are ruined. Nearly 400,000 quintals of nitrate at Iquique and the adjacent ports of Molle and Pisaque were destroyed. A small loss of life took place, probably ten (10) persons in all. Coasting crafts and small boats in the harbour were broken to pieces, away up the Pampas, eleven (11) miles from Iquique.

The splendid nitrate establishment, La Neuva Carolina, was completely destroyed.

The sufferings of the people of Iquique were intense. Absence of water and the destruction of the principal stores added to their hardship. It is estimated that the damage done in Iquique will amount to nearly £800,000.

Other Towns destroyed.

Damage to Shipping.—Chanivave, a little town at Guano Landing Deposit, known as Pabellon de Pica, with 450 houses, has only two standing. In one of the guano cuttings thirty (30) labourers were buried by the falling earth. Among the shipping

the havoc is terrible. The town of Tarabaza, two or three leagues inland, and the villages of Pica, Matella, and Conehones, were more or less ruined. The loss of life is reported small. The earthquake was especially severe at Chanenoogo. The earth opened 15 mètres in depth, and the whole surface of the ground changed. At least 200 were killed. The bodies were floating in the bay. At Huanillas, the guano-loading station, the damage inflicted was fearful. The wave which succeeded the earthquake, and completed the work of destruction, was nearly sixty (60) feet in height. Many vessels were lost here, together with several of those on board. At Mijillones the tidal wave was 65 feet in height. Two-thirds of the town is completely obliterated. At Tecopilla little or nothing remains of the town. A mine called La Pena Bianca, four (4) miles to the southward, sank, smothering 200 workmen, forty of whom were Cornish miners. Cobija, the principal town on the Balactian coast, has lost three-fourths of its houses.

Relief for the sufferers.—As soon as this lamentable intelligence reached Lima, the Government chartered a steamer, and organised a relief commission, loaded a vessel with provisions, clothing, &c., together with 50,000 gallons of water, and despatched her on the 16th for the South; 100,000 soles in silver coin also formed part of her cargo, to be distributed among the unfortunates by a commission of engineers accompanying the expedition. It has been urged by the Government to recommend the rebuilding of the ruined towns on sites which may offer greater security and more remote from shore, since this is the second instance of a similar calamity to the positions occupied. Subscriptions are being made at Lima and Callao for the relief of the distressed. The northern ports of Peru are damaged but little, though the sea was running remarkably high.

The shock at sea.—The captain of the steamer "John Elder" reports that when 23 miles west of Antapagosta, going at full speed, the ship was completely stopped by the shock of the earthquake, and she remained almost stationary for five minutes. The passengers believing she had struck on a reef, soundings were taken immediately, but no bottom was found.

Earthquake in Peru.

Mr. R. A. Proctor, of the Royal Astronomical Society, in speaking of this convulsion, says:—"One remarkable feature in this terrible earthquake is the enormous range of country affected by it. From Quito southwards as far as Iquique, or in other words, for a distance considerably a full third part of the whole length of the South American Andes, the shock was felt with the most terrible distinctness. The immense volcanoes found with

Cordilleras are thought to have some influence in causing the disturbances which are by no means uncommon in these regions; and Humboldt states that the shock which devastated Riobamba in 1797 was so great that he found on the summit of La Culca the skeletons of scores of the inhabitants who had been flung vertically into the air, and alighted on the hill referred to, on the opposite bank of a small river to that on which the town was built.

When these terrific earthquakes occur near the coast they are invariably followed by an upheaval of the water, which assumes the shape of a tidal wave of greater or less magnitude, and in more instances than one the tidal waves have proved infinitely more disastrous than the earthquake. One case, for the sake of example, will serve to demonstrate the magnitude of such a wave as that which razed to the ground the city of Arica. An eye-witness thus describes what he saw of it:—"While passing towards the hills, with the earth shaking, a great cry went up to heaven. The sea had retired. On clearing the town, I looked back and saw that the vessels were being carried irresistibly seawards. In a few minutes the sea stopped, and then arose a mighty wave fifty (50) feet high, and came in with a fearful rush, carrying everything before it in terrible majesty. The whole of the shipping came back, speeding towards inevitable doom. In a few minutes everything was completed—every vessel was either on shore or bottom upwards."

M. Boussingault observes that in the vicinity the trembling of the earth is almost incessant, but this he ventures to attribute in part at least to the immense falling masses of rock that have been fractured by disturbances in the mountains.

In the July number of Frazer's Magazine for 1870, a lengthy account is given of the greatest sea-wave that is reported to have ever occurred, and the effects of which we observed were perceptible in Sydney. Its origin, the course which it pursued, and other minutiæ respecting it, served as subjects for scientific research by savans for many months, and two German geographers, Professor Von Hochstetter and Her Von Tschudi, wrote papers about the wave, and disclosed various facts that will prove of service to those who take an interest in this branch of science. Mr. Proctor's opinion is that "the progress of the great sea-wave which was generated by the upheaval of the Peruvian shores in 1868, and propagated over the whole of the Pacific Ocean, differs altogether from any earthquake phenomena before observed. Other earthquakes have indeed been followed by oceanic disturbances; but these have been accompanied by terrestrial motions, so as to suggest the idea that they have been caused by the motion of the sea bottom, or of the neighbouring land. In no instance has it ever before been known that a well-

marked wave of enormous proportions should have been propagated over the largest ocean track of our globe, by an earthquake whose direct action was limited to a relatively small region, and that region not situated in the centre but on one side of the wide area traversed by the wave.

The origin of the great sea wave seems to have been traced in the first instance to rumblings of the earth at Arequipa, which is situated in the neighbourhood of the volcanic mountain of Misti, which occasionally has been known to vomit streams of lava, dust and ashes, &c. On the evening of the 12th August, or on the morning of the 13th, the inhabitants had, so far as they were aware, no reason to be frightened, as the mountain was perfectly quiet until 5 o'clock in the evening, when slight sensations of a disturbance were visible. Half a minute later, however, a terrible noise was heard beneath the earth; a second shock more violent than the first was felt; and then began a swaying motion, gradually increasing in intensity.

Von Tschudi remarks: "And now there followed during two or three minutes, a terrible scene. The swaying motion which had hitherto prevailed changed into fierce vertical upheaval. The subterranean roaring increased in the most terrifying manner; then were heard the heart-piercing shrieks of the wretched people, the bursting of walls, the crushing fall of houses and churches, while over all rolled thick clouds of a yellowish black dust, which, had they been poured forth many minutes longer would have suffocated thousands. Notwithstanding that the shocks lasted only a few minutes, they were sufficiently severe to demolish the whole town, and not one building remained uninjured. At Tacua and Arica the shocks were felt, but with less severity than at Arequipa. At Arica the earthquake was followed by an immense tidal wave which carried the Peruvian corvette "America" and the U.S. vessel "Watertree" from the harbour nearly half a mile north of the town, and there left them stranded high and dry.

This same wave visited Iquique mentioned in a telegram to-day. It rose to a height of upwards of 50 ft. and then rushed in with inconceivable rapidity, washing down buildings and otherwise doing considerable damage, and bringing in with it great quantities of mud and slime which it had stirred up from the bottom of the sea. The oscillations continued during the 11th, and it was not till the lapse of several days that the tide resumed its customary ebb and flow. The line of the wave when crossing the Pacific is estimated to have measured not less than 8,000 miles. People have wondered at the remarkable rapidity with which the tidal wave reached here on Friday after being felt at New Zealand; but the great wave of 1868 is reckoned to have travelled across the Pacific at a speed of three or four hundred sea miles an hour.

Three hours after the earthquake which destroyed so many towns, the tidal wave inundated Coquimbo on the Chilian coast, some 800 miles from Arica, and slightly more than an hour passed before it destroyed Constitutiscion, 450 miles distant. At Honolulu, where our Pacific mail-boats call, the sea continued oscillating for some three or four days, and many of the islands in the South Seas were totally submerged, until the water had receded. The wave passed the Navigators, and partially submerged some of the low-lying islands, and at Opara in the Marquesas Isle, the coaling depôt of the mail-boats then running was partly washed away.

Mallet, who is regarded as an authority upon these subjects, in speaking of tidal waves, says: "The great sea wave, advancing at the rate of several miles in a minute, consists, in the deep ocean, of a long low swell of an enormous volume, having an equal slope before and behind, and that so gentle that it might pass under a ship without being noticed. But when it reaches the edge of soundings, its front slope becomes short and steep, while its rear slope is long and gentle."

[Three diagrams.]

Some Results of an Astronomical Experiment on the Blue Mountains.

By H. C. Russell, B.A., F.R.A.S., F.M.S., &c.

[*Read before the Royal Society of N.S.W.*, 6 *November*, 1878.]

It has long been my intention to make an astronomical experiment on the Blue Mountains. Four years since, when selecting the transit of Venus stations, I made a hurried trip to Woodford, for the purpose of testing the fitness of that station for observing the great event. My attention was then chiefly directed to the state of the air during the day, and it proved then and at the transit wonderfully steady and clear. I went up in June—the depth of winter—and although the air during the day was all that could be desired, I found that an hour after sunset there was so much motion or unsteadiness in it that its clearness was of no avail for star-work.

I wanted now particularly to test the air spectrum, and see if the lines between the Ds were the same there as at Sydney. There were also several difficult questions about double stars wanting answers and a better atmosphere to get them than I have in Sydney. There were some questions about the thickness of our air currents I wished to answer. And, lastly, there was a desire that this Colony should have some share in answering one of the pressing astronomical questions of the day, viz.: Can anything be done by going on the hills to improve the performance of telescopes which are too powerful to use in the unsteady atmosphere of the plains? The results obtained by Piazzi Smyth, twenty years since, were quite enough to induce others to make the experiment; yet little or nothing has been done in a direction that promises so much for physical astronomy. My object in going in October was to try in what may be considered a mean between winter and summer, and also that I might be able to see Jupiter before he passed away to the sunlight. Woodford, 2,200 feet high, was selected because the supports for the transit of Venus instruments were ready for use; and, to a large extent, I was influenced by the kindness of A. Fairfax, Esq., who placed his country house at my disposal, and so made it unnecessary for me to encumber the expedition with tents to live in, and all the baggage that must go with them. Mr. G. D. Hirst volunteered to go, and I was then sure of enthusiastic assistance.

I left Sydney on the evening of the 15th. On the morning of the 16th, at 8 a.m. the observatory (in parts of course) and the instruments were left at Woodford by the train, and by the evening of that day, and in spite of a steady gale of wind, the observatory was up and roofed, and the heavy parts of the instrument were in their places. On the second day we were able to begin observing about noon.

The instruments consisted of (1) the 7¼-inch Merz telescope, with equatorial stand, clock driving gear, micrometer, eyepieces, &c.; (2) a 4¼-inch Cooke telescope, equatorially mounted; (3) the large spectroscope, having dispersion of 18-64° prisms, fine micrometer, and every appliance to render it complete; (4) heliostat, driven by clockwork; (5) electroscope, thermometers, &c. Of the quality of the 7¼ telescope I need say nothing more now than that it is a first-class instrument, as these results will show, and well adapted for the purpose.

The spectroscope was made by Hilger, of London, and at the time (1876) it was considered the most powerful and perfect one in the world.

At 11·30 a.m. of the 17th October I began the spectroscopic work, and was at once struck by the clear definition of the lines, the gain in clearness over the Sydney atmosphere was very striking, but the next moment I asked myself where were the lines; instead of seven lines between the two Ds there was but one, and on either side of them, where it is usual to see a host of lines, the spectrum was remarkable for their absence. The line D3, however, which I discovered in 1877, was visible definitely but very fine, and on very carefully examining the space between the Ds there was a shading such as would be produced by very fine lines, too faint to be seen separately; these observations were made about noon, and I did not again look at the spectrum until near sunset, when a great change had come over it. Six lines were visible between the Ds, and the usual host on either side; they were more clearly defined than I had ever seen them before, and as the sun approached the horizon they thickened very rapidly; this will be best understood by reference to the drawings herewith.

The 18th October proved a cloudy day and night, with a light easterly wind or sea breeze. Towards morning of the 19th the clouds began to break, and soon after 9 a.m. the sun shone out. At 10·30 there were a few passing clouds only, but the sky was very white like it is in Sydney; and looking at the spectrum I found six lines between the Ds. The clouds were disappearing fast, and by 11 a.m. it was difficult to make out the six lines, they also, were fading fast; on either side there seemed to be a shading such as was seen on the 17th. At noon the air lines had faded, and the spectrum appeared as in figure 1, that is

without air lines, those shown being evidently part of the solar spectrum. At 4 p.m. seven lines could be distinctly seen between the Ds, and the first set of measures were taken; and at 5·20 p.m., when the air lines were getting better defined, I measured twenty lines between C.A. and D 1, where only three lines had been seen at noon; their positions are shown in diagram 3, as well as the D lines seen at the same time.

After these measures had been taken, the micrometer was removed and an eyepiece that defined a little better was used, and twenty-four lines were counted where only twenty had been measured and I found for the first time an eighth line between the Ds; the definition was wonderfully fine and steady. Just as the sun was setting I counted twenty-six lines instead of the twenty above measured; in fact, new lines seem to be coming into the spectrum every minute. These are lines produced by the absorption of our atmosphere; and it is no longer surprising that the sunlight decreases rapidly as the sun leaves the meridian, when one sees the lines starting into being like so many black strokes from a pen, each one having definitely hidden so much of the sunlight; and it is not simply by the increase in number—there is a great increase in thickness of most of them, and one gets fully ten times thicker on the horizon than it is on the meridian.

Another fact was now clearly made out. In Sydney, owing to unsteady definition near the horizon, I had been led to suppose that the D 2 became twice as thick, and that D 3 disappeared. Now I learn that the thickening was due to D 3, and at sunset it seemed another D 2, and only the faintest line of light separated these lines. See diagrams 2 and 4.

While observing the spectrum to-day, I noticed a bright line near D line 6. I have seen the same less distinctly in Sydney; it was no subjective effect of contrast. Mr. Hirst also saw it very distinctly; it is not a defined line, but a bright streak, and I find its wave length is, taking a mean of three measures, 5893·05, and it is worthy of note that 5894 is the position of one of the zinc lines. On the 20th October the day was fine, but the sky was streaked with cirrus; at 12h. 30m. p.m., I can make out very faintly five lines between the Ds, but they are almost invisible—little better than shading; and between Ca and D 1 are the three lines seen yesterday and the positions of eight others, mere ghosts of themselves, can be made out. At 5h. 10m. p.m. two sets of measures of the eight lines between the Ds were taken, and line 8 was estimated, much the faintest of all of them. At 5·40 p.m. twenty-two lines were counted between C and D 1, and D 3 is rapidly thickening—it is nearly half as thick as D 2; and line 6 is darker than line 4 which looks a little hazy. 5·50 p.m., count twenty-six lines between Ca and D 1, and the three next D 1 are very dark and thick (intensity 2).

The fourth line from D 1, that is the line always there, seems to get wider at sundown without getting blacker as the others do, as if it were a double line, or that another air-line appeared alongside of it. I have several times suspected that it was double, and now I am almost sure of it. D 3 at sunset nearly equal D 2, and the two are only separated by the faintest streak of light.

9·25 a.m. on the 21st, I can see all the eight lines between the Ds faintly; morning is warm and hazy, and a good deal of cloud about, especially in the direction of the sun. 11h. 10m., the air lines are rapidly fading; line 4 does not seem changed, but the others are more or less invisible.

Measures of the lines between the two Ds mean of three taken at Woodford, on the afternoons of 19th October, 1878, 4 p.m., and 21st October, 5·10. The measures are taken from line to line, and represent parts of the micrometer. The whole distance D1 to D2 is covered by 2·655R parts of the micrometer:—

D1	1	2	3	4	5	6	7	8	D2	D3
·336	·366	·360	·356	·203	·256	·263	·346	·131	·201	

Some of the members present may remember that, when I brought my Sydney measures of the D line before you last year, I produced a copy of Dr. Huggins's drawing of the D lines at Oxford, and those of Colonel Campbell at London. Since then I have received from Dr. Huggins a more complete and perfect copy of his drawing of the lines between the Ds and it is interesting to compare it with those observed here; there is very little similarity between his drawings and mine. From Mr. Hilger, the maker of my spectroscope, I learnt that, before he sent it out, he tried it in London, and saw twenty-four lines between the Ds; unfortunately I have no drawing or measure of these. These facts point clearly to the conclusion which I brought before you, viz., that our atmosphere contained much less of that absorptive matter, whatever that might be, than does the atmosphere of England, and especially London. Knowing the proverbially clear atmosphere of our western hills, I was the more anxious to test this question of purity by means of the large spectroscope, and see if we might affirm that it stood the test. Now the facts which I have brought before you do this most emphatically; on a fine clear day, with dry wind on the mountains, at noon, there is not a single line due to the absorption of the atmosphere in the part of it examined; but as the sun sinks to the west, they gradually appear; and when he is setting, and the vapours begin to condense about the hills, the lines stand out conspicuously; or let an easterly breeze bring the moisture from the sea, and at once the lines appear at noon. Of course I have been dealing with only a small fraction of the solar spectrum; to take the whole in such detail would require the labour of a life,

and would, I am sure, well repay it. My time was but a few days (three and a half only available for the purpose), and I could of course only take a small part; but it may very fairly be taken as a sample of the whole, and there can, I think, be no doubt that the cause of these lines is water vapour, and that if any of the twenty-four lines which are visible in London are due to gases which are the product of manufactures, we in Sydney have so far not contaminated the air in this way; for the lines visible in Sydney are likewise visible upon the mountains, when there is sufficient moisture present for the purpose. It was a sight never to be forgotten to see in the splendid definition of the mountain air, the clear solar spectrum, and then, as the day waned, line after line coming into view as if drawn with a pen, and getting blacker and more defined as the sun neared the horizon. The line which I have called D 3 is a wonder. At midday it is a fine thin line, and at sunset it is fully ten times darker. With regard to the line 8, which I have never seen in Sydney, I feel sure it would be visible were the air steady enough. I have observed a shading there, but could never see the line. With regard to the other portion, Ca to D 1, mapped at Woodford, I cannot say much, for it has not yet been mapped in Sydney. It is a perfect mine of air lines. How many would be found in it in London it is hard to say, but towards sunset the lines seemed almost to cut out the sunlight.

Now, with regard to telescopic work. On the 16th October the day proved as fine as the one which preceded it, and which had been lost in erecting the observatory. About noon on 16th the telescope was turned to the sun, and its edge and surface markings were beautifully seen, but not a spot was visible whose changes we could record. There were many exclamations from the observers about fine definition, but we wanted spots, and could not find even the faculæ which precede them; for once the sun was spotless. Several stars were observed in the sunlight with the object of adjusting the instrument, and the sharp clear discs which they presented gave us abundant proof of the good observing quality of the air. At night the feature that seemed most striking at first was the perfect blackness of the sky. There was no white halo round Jupiter forming a bright background; and my notes are full of such remarks as ("planet seems hung in a perfectly black sky"), but as one looked, the perfect clearness and definition, but perhaps most striking, the clearness, gave us views of Jupiter such as I think I never saw equalled. There was such an amount of detail that the eye scarcely took it all in before the scene changed by the rotation of the planet. As to drawing it all, that was out of the question. Mr. Hirst and I both tried, and I am sure he will bear me out when I say that the drawings only show a fraction of what we saw.

It was just before and after sunset that the air seemed so perfectly steady; later in the evening there was a little motion, but it was nothing like so much as I had seen when on the mountains in the winter of 1874.

I had selected some severe star tests, as a trial of the observing quality of the mountain air, and when I turned the telescope to the stars I was not disappointed. The companion to Rigel has recently been found itself to be a double star by one of the keenest of American observers; he was led to think it was double with a telescope of 6 inches aperture; but it required all the power of one of 18½ inches to place the matter beyond question. You may judge, therefore, that we looked for this closest of known double stars with considerable interest on the first available night, and the old 7¼-inch telescope fully maintained its first-class character. We used a power of 800 (the highest I had) with advantage, and directly I looked at the companion to Rigel I saw it elongated, and it appears so with all powers over 400. It was evident that the components were unequal, the smaller one following; independently Mr. Hirst and myself observed it, and agreed in assigning the position angle of 64°, and in moments of best definition, for at midnight the air was not so steady as it was at sunset, the star seemed to me clearly divided with a magnifying power of 800, though I am sure the distance cannot be more than one quarter of a second. As proof of the definition, it may be mentioned that under such a high power Rigel presents a hard and clearly defined disc.

On the 20th he was again examined, and Mr. Fairfax independently made the angle the same; there could therefore be no question as to what it was, and I was not a little surprised to find, on reference to Mr. Burnham's position, that he made it 179°. This is very remarkable. I am confident the result at Woodford is as correct as such an observation can be, and I have confirmed it with the large telescope in Sydney. If Mr. Burnham's observations are right, then we shall have a most wonderful double star, as well as the most difficult known, for his observations were made in February and March, 1878, this year. and our observations point to a change of angle of 115°. The distance as estimated cannot be more than a quarter of a second. Of other stars, a great many were examined; Alpha Indi had been suspected of duplicity in Sydney, but on the mountains his character was restored as a well-defined, round star, and single. On the 17th, when looking about, I found a very beautiful double star that is not in Herschel's catalogue, and I do not remember having seen it before. Its right ascension is 21 h. 28 m., and declination south 83° 20′ the magnitudes are 9 and 10 —the larger one white, and the small one bright blue—2·82 sec. distance, and angle 112° 10′.

Herschel's double 5326 cannot be found; there is no such double in the place he assigns, and there must be either a mistake in his catalogue, which is probable, or a disappearance of one of the stars.

5326 in Herschel's catalogue was examined, the stars are fully a magnitude less than he estimated them, and are now 10 magnitude.

H. 5321 seems to be an error in Herschel's list—angle is given 124°, it is now only 19° 18′; distance, 10° 29′ sec.

5132 H.'s angle of this star is 180°, in error; it should be 312°

Examined H. 3419. He says nothing about colour in either star; as seen on the mountains, the larger star was greenish yellow, and the companion copper-red. On 13th August, 1873, I discovered a very pretty double star, R.A. 18h. 21m., dec. 66° 22′, large one yellow, other blue, distance 5·02 secs., angle 295° 14′. This was re-examined at Woodford, where it seemed a beautiful object with the same colours; but the distance measured there is 3·79 secs., and angle 288° 43′, so that there appears to be decided and rapid motion in this pair.

At 1 h. 34 m. R.A. and dec. 56° 41′, found a very pretty double star, both components yellow, and of 7th magnitude; distance is 6° 28′ secs., and angle 235° 0′.

Many other stars were examined, and some questions raised about double stars, which there was not time to answer at Woodford.

Some time was given to Saturn, and clear views obtained, but the planet is not in a good position for observation just now, for it is very difficult to tell whether a dark line which appears across his body is wholly the shadow of the ring, or made up of that and the dark line which I found four years since, and which, it appeared at that time had not been seen in Europe.

On the afternoon of the 20th October watched the third satellite as a dark body crossing the disc. It seemed remarkably small, and the definition was splendid. As it neared Jupiter's limb, the blackness seemed to get hazy, as if it were seen through a mist, and at 7h. 27m. p.m. I lost sight of it; four minutes later it was detected as a small bright bulge on the limb of Jupiter, and its white edge against the black sky background looked whiter than the edge of Jupiter. At 7h. 36m. 40s. egress was complete, and there was nothing about its bright appearance then that would have given rise to the suspicion that it was black a few minutes before.

During the daylight hours, when I was at work with the spectroscope, Mr. Hirst employed some of his time in looking up Venus near the sun, and many other objects, principally well-known double stars; and of these some splendid views were obtained, but he found nothing about which I wish now to detain you, until the morning of the 21st, at 9h. 5m., when, on looking at the moon, he found that a large part of it was covered with a dark shade, quite as dark as the shadow of the earth during an eclipse of the moon. Its outline was generally circular, and it seemed to be fainter near its edges. Conspicuous bright spots on

the moon could be seen through it, but it quite obliterated the view of about half of the moon's terminator (or that part where the sunlight ends), while those parts of the terminator not in the shadow could be very distinctly seen. I should estimate the diameter of the shadow from the part we could see on the moon at about three-fourths that of the moon.

This is one of those remarkable facts which, being seen, should be recorded, although no explanation can at present be offered. One can hardly resist the conviction that it was a shadow, yet it could not be the shadow of any known body, and if produced by a comet it must be one of more than ordinary density, although dark bodies have been seen crossing the sun, which were doubtless comets. No change in the position of the shade could be detected after three hours' watching. Mr. Hirst has faithfully copied on this paper what he saw. See *photo-lithograph.*

I went prepared to make some experiments upon the thickness of the air currents, and also of the electrical condition of the air strata, but in this matter I was disappointed; although we made every effort to get kites up above the lower current, it was useless. Although on the afternoon of the 17th, in a moderate north-westerly wind, we managed to get the large kite up about 1,000 feet, there was no sign of another current, and very little electrical effect. Mr. Hirst's experience with electrical kites became valuable, and he constructed a smaller one, which was attached to the large one, and thus we hoped to get it high enough; but on the 18th the westerly wind was done, and we got a light easterly, which would not raise our kites. The small one was tried time after time, and rose to about 100 feet, when it seemed suddenly to lose the wind and no amount of vigorous running would take it higher. Whether this represented the thickness of the light easterly wind I cannot say, because it was so puffy on the surface that it seemed more probable the kite fell in one of the lulls. On the 19th, with light easterly wind, an altitude of about 400 feet was reached, but no amount of professional effort would get it higher, and the work with so small a result was getting wearisome. On the 21st we had a return of the westerly wind and our hopes revived, but were again disappointed. One fact, however, is worth recording. At 10·30 a.m., the kites would rise from 100 to 200 feet, and then begin gyrating, as if the air was full of eddies; and when the two were flying together, the smaller flying above the large one, and attached to it, the direction of the two strings sometimes included an angle of 40°. In one observation the string of the large (lower) kite pointed E.S.E., while the small (upper) one pointed E.N.E., and yet their heights were respectively 100 and 200 feet. About 11 a.m. things were improving, an altitude of some 300 feet was attained, with wind from W.N.W.; and then suddenly the wind dropped,—another proof that these were merely local eddies in which we had been trying to raise the kites.

It was remarkable that during the time we were there little or no electrical indications could be obtained with a delicate gold-leaf electroscope, even when the air was dry and matches for collecting it were burnt. Some experiments were made on a warm dry day (October 21) on the electroscope. A single rub with a white felt hat made the leaves diverge to the horizontal point, and they stood for a few seconds inclined 60°, and did not come together for two minutes. Mr. Hirst then stood on an old bottle that was found on the ground, and he put one hand on the electroscope, and directly I rubbed any part of his clothes with a piece of glass, a divergence of some 20° was obtained. One afternoon, when tired of attempts to measure what we could not get (atmospheric electricity), Mr. Hirst took the electroscope to a place where the telegraph lines were within reach, and hung it on one wire after another, without getting a sign of anything—which was the more remarkable, as there were thunder-clouds in the distance, and these wires passed right over the mountains.

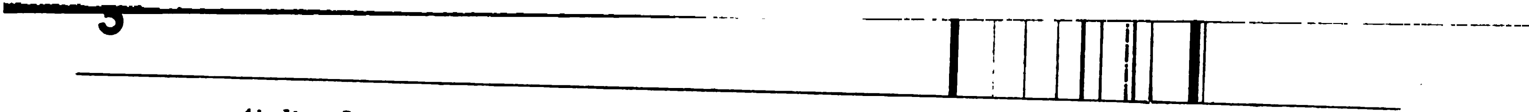
I will not detain you with any speculations about what an observer might see in a mountain atmosphere, but it is right to say one word about the weather. For some weeks before the 15th October the weather had been very unfavourable in Sydney for observations; and during the time I was on the mountains, although it was fine in Sydney on the same nights it was fine at Woodford, yet there was no improvement in the atmosphere generally affecting both places; the gain which I have described was clearly owing to the fact that we were 2,200 feet higher, and therefore avoided so much of the worst part of the air nuisance (for such an astronomer may fairly call it). Could he but look through a vacuum, many a question that takes years of patient labour to answer would be decided in a single glance.

Recorded lines between Ca and D[1], and the positions of the lines A,B,C, seen at Woodford.

Ca, 5857.	
Osmium, 5858.	
Gold, 5862.	
Titanium, 5865.	
Iodine, 5866. Sulphur, 5866. Palladium, 5866.	Air line, 5866 A.
Bromine, 5868.	
Mercury, 5871.	
	Air line, 5872 B.
Lead, 5876.	
	Air line, 5879 C.
Gold, 5880. Iron, 5880.	
Mercury, 5885.	
Molydenum 5887.	
Palladium, 5888.	
D[1], 5889.	

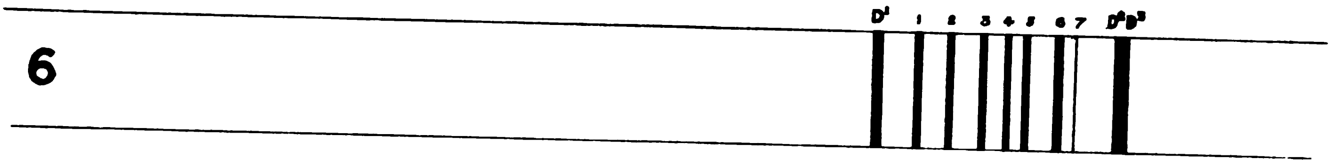
[Two diagrams.]

5



Air lines between Ds as usually seen at Sydney at noon. Dotted streak is a bright line seen at Sydney Oct 6. 1878.

6



Sunset.

PHOTO-LITHOGRAPHED AT THE GOVT. PRINTING OFFICE,
SYDNEY, NEW SOUTH WALES.

THE MOON

Aperture 7¼. Focal length, 10 ft. 4 in. Power used, 150.

Remarks.

The peculiar black shadow represented above was observed partly obscuring terminator.

$9^h 5^m$ a.m.

Woodford, 21 Oct., 1878.

Geo. D. Hirst.

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The peculiar black shadow represented above was observed partly obscuring terminator.

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Woodford, 21 Oct, 1878.

Geo. D. Hirst.

On the Metallurgy of Nickel and Cobalt.

By W. A. Dixon, F.C.S., M.I.C.

[*Read before the Royal Society of N.S.W.*, 3 *July*, 1878.]

Shortly after the discovery of the large deposits of nickel and cobalt ores in New Caledonia I turned my attention to the metallurgy of these metals, and began this research with a view to improvements in their extraction, keeping in view the fact that here the reagents usually employed in their extraction are exceedingly expensive.

The sources of nickel, previously to the discovery of these deposits, consisted chiefly of speiss, the residue from the manufacture of smalt, which contains from six to eight per cent. of nickel and three of cobalt, and a few pyritous ores containing copper and nickel. The details of the processes used for the extraction of the metal from the former are jealously guarded by the manufacturer as trade secrets, but the method adopted is, in general outline, to fuse the speiss with fluor-spar and chalk to remove part of the iron and obtain an enriched matt. This matt is ground, thoroughly roasted, to expel arsenic and sulphur and convert the metals into oxides, which are then dissolved in hydrochloric acid. The solution is diluted with water, any ferrous chloride converted into ferric chloride by a solution of hypochlorite of calcium, and the iron precipitated by the cautious addition of milk of lime, any arsenic being removed at the same time. Sulphureted hydrogen is then passed into the fililate to precipitate copper, and from the clear solution cobalt is precipitated by hypochlorite of calcium, and afterwards the nickel by milk of lime.

It seemed probable that the nickel in the New Caledonian ore, occurring as it does in serpentine, might have been deposited from an acid solution percolating through the magnesian rocks, and that if this process could be reversed the nickel might be again obtained in solution. Digestion with ammoniacal solutions of magnesium sulphate and chloride and calcium chloride at various temperatures was therefore tried, but minute quantities only of nickel were dissolved, though in every case distinct traces were obtained.

Trials were made with the view of taking advantage of the comparatively easy decomposition of magnesium chloride by aqueous vapour at a high temperature. The nickel and magnesium were obtained together in solution evaporated to dryness and treated with steam at various temperatures ranging from 212°F. to dull redness, but much nickel chloride was invariably decomposed along with the magnesium chloride.

A portion of the ore in pea-sized pieces was then treated at a dull red heat in a combustion tube with dry hydrochloric acid gas, with the view of converting the nickel into chloride, whilst the magnesium remained as silicate. Water was freely given off and the pieces of ore became covered with crystals of anhydrous chloride of nickel. The effect was very beautiful as the golden-yellow scales of chloride gradually grew out of the ore until each piece seemed converted into a golden ball. The chloride was readily dissolved out by hot water, but numerous trials gave only an average of 3·62 per cent. of nickel extracted from an ore containing 10·66 per cent. The solution contained both ferrous and magnesium chlorides in small quantities. Its composition, calculating the metals as dry chlorides, was:—

Ferric chloride, traces.		
Ferrous	do.	5·42
Magnesium	do.	12·45
Nickel	do.	82·13
		100·00

From finely-ground ore similarly treated for five hours 6·73 per cent. of nickel was extracted, whilst no increase was observed on continuing the treatment for two hours longer.

It seemed therefore as if part of the metal was in more intimate combination with the silica than that extracted; so with a view to decompose this silicate different portions of the residue were treated at a red heat with hydrogen, coal gas, and finely-divided carbon (obtained by mixing starch with the ore), and afterwards roasted to re-convert the reduced metals into oxides. On further treatment with hydrochloric acid gas 1·65 per cent. of nickel was obtained, still leaving 3·93 per cent. There was little apparent difference between the reducing agents, although on the whole the carbon seemed the best. The solutions obtained after reduction were much more impure than those got in the first instance, showing more iron than nickel. Calculated as before, they contained:—

Ferrous	chloride	47·36
Magnesium	do.	16·80
Nickel	do.	35·84
		100·00

These results were obtained with a somewhat friable ore containing much ferric oxide, but it was observed that some dense varieties yielded scarcely any chloride of nickel by this method.

When a charcoal chaufer was used for heating the tube, on some parts of it small brilliant black crystals were deposited. These were highly magnetic, aud contained ferric oxide and nickel oxide, and probablv contained ferroso-ferric oxide with the whole or greater part of the ferrous oxide replaced by nickel oxide, but sufficient for an analysis was not obtained. They seemed to be formed on those parts of the tube which were over-heated, but some other circumstances contributed to their formation, as repeated trials to obtain them in larger quantities failed.

These experiments, although failing to separate the nickel from the silicate, showed that oxide of nickel could be separated from ferric oxide by treatment with gaseous hydrochloric acid, so the behaviour of the mixed oxides was next examined.

The New Caledonian ore is very infusible, from the large proportion of magnesia it contains, and some cheap flux containing other silicates was necessary to obtain the nickel in a metallic or reguline state. This was found in copper ore furnace slag, which with half its weight of ore yielded a sufficiently fusible charge. The alloy of iron, nickel, and copper obtained by fusing with carbon only as a reducing agent was too tough to grind and was therefore difficult of conversion into oxides, but the addition of arsenical pyrites readily yielded brittle buttons which were easily pulverized. Indeed a piece of arsenious oxide thrust into the fused mass in the crucible gave a similar result, as was also the case with iron pyrites. Thus a mixture of 400 grains ore, 100 grains mispickel, and 800 grains copper slag gave a button weighing 175·6 grains, and containing 63 grains nickel, whilst the yield should have been 66 grains. Again, 400 grains ore, 800 grains slag, with 50 grains pulverized charcoal being fused, 90 grains of arsenious oxide was thrust into the molten mass, and a button was obtained weighing 271 grains, containing 64·8 grains nickel, showing a loss of only 0·8 per cent. of the nickel in the ore. The various buttons were crushed and roasted, and the oxides were treated with hydrochloric acid gas (from which aqueous vapour was partially removed by passing it through a Leibig's condenser) at dull red heat. The whole caked together into a mass from the nickel chloride formed; so, to render it permeable, it was removed, crushed, and retreated until water ceased to be evolved. With boiling water a solution was obtained containing nearly all the nickel, but at the same time a considerable quantity of ferrous chloride, whilst ferric oxide with traces of nickel remained.

It was evident, therefore, that a more thorough calcination was required to effect the separation of the iron and nickel, but it was difficult to determine when the calcination had been carried far enough, as the presence of copper and nickel obscured the usual reaction for ferrous oxide. It was found, however, that by treating a sample from the muffle with hydrochloric acid until complete solution was effected, cautiously mixing with this solution an equal bulk of sulphuric acid, boiling to expel the hydrochloric acid, and adding to the cooled solution a crystal of potassium nitrate, the characteristic brown colour was rapidly developed as long as ferrous sulphate was present.

As speiss was actually the substance under treatment, it was thought advisable to examine the behaviour of the other oxides which are generally contained in it. A speiss was therefore made with ore and various residues, and after calcination was found to contain 41 per cent. of oxide of nickel with the oxides of iron, copper, zinc, cobalt, and arsenic. These oxides treated as before yielded in a flask attached to the outlet a solution containing arsenic and zinc which had been volatilized as chlorides, and the residue on boiling with water a solution containing nickel and cobalt with a small quantity of iron. The insoluble residue contained the ferric oxide, a small quantity of nickel oxide and copper as cuprous chloride, which could be removed by a solution of salt.

It now remained to separate the small quantity of iron in the solution from the nickel and cobalt and these metals from each other, and it seemed desirable to do so without adding fixed reagents. It was found that this could be done by passing chlorine into the solution until all the iron was in the form of ferric chloride, and then adding to the boiling solution successive small portions of anhydrous oxide of nickel, which dissolved, precipitating the iron as a basic chloride. The precipitate was dense, and contained a small quantity of oxide of nickel added in excess. From a neutral solution containing ferrous chloride it was also found that manganese dioxide completely precipitated the iron without a trace of nickel or cobalt.

On adding to the hot iron free solution rather more oxide of nickel than was equivalent to the cobalt present, and passing chlorine into it, the whole of the cobalt was precipitated as cobaltic oxide, and a pure green solution of chloride of nickel obtained. This solution evaporated to dryness and ignited in a current of steam evolves hydrochloric acid, and leaves oxide of nickel, which may be reduced in the usual manner. The chloride could also be reduced directly to metalic nickel by igniting in a current of hydrogen; and in the case of a solution containing

manganese, this would be advantageous, as its chloride is not reduced by hydrogen, and could be separated from the nickel by washing.

The precipitated cobaltic oxide was suspended in water and treated with chlorine at the boiling point, whilst small quantities of chloride of cobalt was added until cobalt remained in solution. All the nickel was thus removed from the precipitate to the solution, which contained also the cobalt added in excess. The same result could be obtained by digesting the precipitate with dilute hydrochloric acid, which would dissolve the nickel only.

Attached is a scheme which shows the process at a glance, with the destination of the intermediate products; and, although somewhat complicated, it must be remembered that six metals have to be separated, and that two of these—nickel and cobalt—are perhaps the most difficult of all metals to separate satisfactorily. The separation is moreover effected without having voluminous precipitates, such as ferric and nickel hydrates, four or five ounces of which occupy a cubic foot of space, to treat and wash, whilst the reagents used are in great part recovered in an available form. It is scarcely necessary to observe that if the number of metals present is reduced, the treatment would be correspondingly shortened and simplified.

CALCINED speiss containing oxides of nickel, cobalt, copper, zinc, iron, arsenic.

1. Treated with gaseous hydrochloric acid gives—

<table>
<tr><th>Distillate.</th><th colspan="6">Residue.</th></tr>
<tr><td rowspan="9">Containing zinc and arsenic.</td><td colspan="6">Containing ferric oxide, cupreous chloride, ferrous chloride, nickel chloride, cobalt chloride, with traces of nickel and cobalt oxides.
2. Treated with hot water gives—</td></tr>
<tr><td>Residue.</td><td colspan="5">Solution.</td></tr>
<tr><td rowspan="7">Containing ferric oxide cupreous chloride.
Traces nickel and cobalt.
Treated with brine, gives solution of cupreous chloride, from which copper precipitated by iron.
Residue, other metals, returned to melting-furnace.</td><td colspan="5">Containing ferrous, nickel, and cobalt chlorides.
3. Treated with chlorine till all ferrous converted into ferric chloride, and then boiled with oxide of nickel.</td></tr>
<tr><td>Precipitate.</td><td colspan="4">Solution.</td></tr>
<tr><td rowspan="5">Ferric oxide and oxychloride, with the excess of nickel oxide.
Returned to roasting-furnace.</td><td colspan="4">Containing chlorides of nickel and cobalt.
4. Treated with chlorine in presence of oxide of nickel.</td></tr>
<tr><td colspan="2">Precipitate.</td><td colspan="2">Solution.</td></tr>
<tr><td colspan="2">Cobaltic oxide and excess of nickel oxide added. Treated with dilute hydrochloric acid.</td><td colspan="2">Pure nickel chloride, evaporated to dryness, and ignited in current of steam.</td></tr>
<tr><td>Residue.</td><td>Solution.</td><td>Gas.</td><td>Residue.</td></tr>
<tr><td>Cobaltic oxide.</td><td>Nickel chloride.</td><td>Hydrochloric acid returned to 1.</td><td>Oxide of nickel to reducing-furnace.</td></tr>
</table>

The Deep Well Waters of Sydney.

By W. A. Dixon, F.C.S., F.I.C.

[*Read before the Royal Society of N.S.W.*, 2 *October*, 1878.]

The obtaining of a Water Supply for Sydney by means of Artesian Wells has been mooted at different times, and the successful results obtained in other countries have been cited to encourage a search for subterranean water, both in our immediate neighbourhood and elsewhere in the Colony. It has been suggested, indeed, that the great supply of water drawn from the Botany Swamps during the drought of 1876 might be partly due to natural artesian springs rising beneath the sand.

Two wells of this description have already been sunk in Sydney, and I now venture to lay before you analyses of the waters obtained, with some conclusions drawn from them. The following are analyses of the Sydney water, as supplied in Hunter-street, in May last, and of a surface spring near Waverley, analysed nearly two years since for comparison with the deep waters:—

Sydney Water.

Carbonate of calcium... ...	0·07 grains per gallon.
Alumina and iron oxide ...	traces „ „
Chloride of magnesium ...	1·15 „ „
„ sodium	2·11 „ „
Loss on ignition	·41 „ „
Sulphates	traces „ „
Total solids	3·74 „ „

The residue darkened slightly on ignition, and contained traces of nitrates and—

Free ammonia...	0·01 parts per million.
Albuminoid „	0·08 „ „

Spring at Waverley.

Carbonate of calcium ...	1·90 grains per gallon.
Chloride of magnesium ...	2·15 „ „
„ sodium	3·50 „ „
„ potassium ...	traces „ „
Sulphates	traces „ „
Loss on ignition	1·91 „ „
Total solids	9·46 „ „

The residue scarcely tinged on ignition, nitrates were absent, and the water contained—

Free ammonia	0·01 parts per million.
Albuminoid	0·26 „ „

In 1876 the Colonial Sugar Refining Company began to bore for water at their new works at Pyrmont, and at a depth of 200 feet they obtained a supply of water, of which the following is an analysis, made in August, 1876:—

Carbonate of calcium...	10·12	grains per gallon	Deposit on boiling, 13·63
Oxide of iron	3·51	„ „	
Sulphate of calcium ...	·72	„ „	
„ magnesium	3·76	„ „	
Chloride of magnesium	·69	„ „	
„ potassium	3·05	„ „	
„ sodium ...	21·65	„ „	
Loss on ignition ...	6·36	„ „	
Total solids ...	49·86	„ „	

This sample of water was sent in a cask, which charged it with organic matter, so that it was useless to determine the organic nitrogen.

The supply of water found at this depth proving inadequate, boring was resumed until at a depth of 427 feet a more abundant supply was tapped. A well 127 feet deep and 5 feet in diameter was sunk close to the bore and a drive put through to form a connection. The well was perfectly dry for its whole depth, showing that surface water was completely excluded. The water rose to a height of between 3 and 4 feet above high-water mark, and rose and fell slightly with the tide. This has been noticed in other wells, as, for example, that at the palace of the Bishop of London, at Fulham, which is bored to a depth of 300 feet, yields from 60 to 80 gallons per minute, according to the state of the tide. Continuous pumping reduced the level of the water at Pyrmont; and somewhat curiously, on the pumps being stopped, the water only rose to within about 4 feet of its original level, and on being left at rest for a week it gradually rose 2 feet further, being still 2 feet under the first height. Quite lately Mr. Poolman has told me that after several months continuous pumping the water does not rise within 30 feet of its original level, on the pumps being stopped.

The water was analysed in June, 1877, and gave—

Carbonate of calcium...	13·55	grains per gallon	Deposit on boiling, 15·09
Oxide of iron	1·54	„ „	
Chloride of calcium ...	1·13	„ „	
„ magnesium	11·12	„ „	
„ potassium	1·40	„ „	
„ sodium ...	10·85	„ „	
Sulphates	traces		
Silica and alumina ...	·31	„ „	
Loss on ignition ...	7·09	„ „	
Total solids ...	46·99	„ „	
Total chlorine...	16·18	„ „	

The residue blackened slightly on ignition, nitrates were absent, and the water gave

Free ammonia...	0·27	parts per million.
Albuminoid ammonia... ...	0·01	„ „

In the beginning of the present year the Company began to draw on the well to its full extent, pumping about 50,000 gallons per day, and with this draught a considerable quantity of fine clay was pumped up. The clay is of a grayish colour, and contained a trace of carbonate of calcium; it was examined by the microscope for diatomaceæ, &c., with negative results. With the continuous pumping, the water gave indications of having altered somewhat in character; so a sample drawn on the 1st of March was analysed, and gave—

Carbonate of calcium ...	15·60	grains per gallon	Deposit on boiling, 15·60
Oxide of iron ...	traces.		
Alumina, silica, &c. ...	5·71	„ ,	
Sulphate of calcium ...	1·03	„ „	
Chloride „ ...	2·37	„ „	
„ magnesium...	3·84	„ „	
„ potassium ...	1·13	„ „	
„ sodium ...	24·89	„ „	
Loss on ignition ...	9·15	„ „	
Total solids ...	63·72	„ „	
Total chlorine ...	20·15	„ „	

The residue blackened slightly on ignition, nitrates were absent, and ammonia was not determined.

This analysis shows mere traces of iron, and it seems likely that the iron in the previous sample was due to particles of iron abraded from the boring rods and left adhering to the bore. It showed, however, a notable increase in the saline constituents of the water, and especially in the amount of chlorine, which showed 4 grains per gallon more than the first. To see whether any further increase took place the water was examined regularly for some weeks, the chlorine being determined and also the free and albuminoid ammonia, the amounts of which were also found to have risen. The following are the results of this examination, the chlorine being stated in grains per gallon, and the ammonia in parts per million:—

	Chlorine.	Free ammonia.	Albumenoid.
Mar. 12	21·30	0·24	0·48
„ 15	20·66	0·32	0·38
„ 23	21·08	0·30	0·36
„ 30	21·09	0·37	0·39
Apr. 8	20·87	0·35	0·38
„ 16	21·30	0·36	0·39
Average	21·05	0·325	0·397

The upper part of the well was at this time carefully examined to find whether any percolation from the waters of the harbour was taking place which would account for this result, as some blasting operations had been carried on in the neighbourhood, but for the whole hundred feet the walls were found to be dry.

The second boring put down for water is that of Messrs. J. T. and J. Toohey, of the Standard Brewery. In 1875 they put down a well to a depth of 79 feet, and a bore to a total depth of 180 feet, and obtained a supply of water which gave on analysis—

Oxide of iron	...	1·55	grains per gallon.
Sulphate of calcium	...	1·58	„ „
„ magnesium	...	·61	„ „
Chloride „	...	5·63	„ „
„ sodium	...	13·58	„ „
„ potassium	...	traces.	
Loss on ignition	...	2·82	„ „
Total solids	...	25·77	„ „

The residue scarcely tinged on ignition, nitrates were absent, and the water contained:—

Free ammonia	...	0·01	parts per million.
Albuminoid ammonia	...	0·04	„ „

The quantity of water obtainable at this depth being insufficient for their use, and the Sugar Company having obtained an abundant supply at a greater depth, boring was recommenced, and at

a depth of 380 feet water was again struck in the end of January. The boring rods seemed to have suddenly dropped, as some of the screw threads were stripped for a length of two and a half inches. The following is an analysis of a sample drawn on the 5th February—

Carbonate of calcium ...	4·20 grains per gallon.		Deposit on boiling, 4·20
Oxide of iron ...	traces.		
Alumina and silica ...	4·42	„ „	
Sulphate of calcium ...	2·14	„ „	
„ magnesium...	1·20	„ „	
Chloride of „ ...	0·66	„ „	
„ sodium ...	15·59	„ „	
„ potassium...	traces.		
Loss on ignition ...	4·34	„ „	
Total ...	32·55	„ „	
Total chlorine ...	9·95	„ „	

The residue darkened slightly on ignition, nitrates were absent, and the water contained—

Free ammonia ...	0·02 parts per million.
Albuminoid ...	0·07 „ „

This well was drawn upon generally to the extent of 10,000 gallons per day, and on the 8th of May, when the maximum yield of the well had been pumped from it during the previous twenty-four hours, a sample was taken and examined for chlorine and ammonia, and was found to contain—

Chlorine	12·00 grains per gallon.
Free ammonia ...	0·12 parts per million.
Albuminoid „ ...	0·14 „ „

It is evident from this, that when the wells are fully drawn upon, the same cause operates to increase the amount of chlorine and ammonia in both waters, and it seemed probable that the supply came from crevices along which it formerly flowed until it escaped at the outcrop below the sea. This underground flow and escape of fresh water into the sea elsewhere, and that often in large quantities, is evidenced by Humboldt's description of a submarine spring in the Gulf of Mexico, some considerable distance from the South American coast, which converts so large a space into a fresh water lake that it is inhabited by the fresh water cetacea found in the Orinoco ("Travels"); also, by Buchanan, who found "an abundant spring of fresh water in the Indian Ocean, 125 miles from Chittagong and 100 miles from the coast of the Sunderbunds. ("Tomlinson's Cyclopedia: Art. 'Artesian Wells.'")

The bore, in the cases under consideration, opened a new outlet for the water, and allowed more water to rise through it than the crevices supplied, and therefore a slight flow was established from the sea to the bore along the old channel.

If this theory was correct, the ratio of the chlorine to the free and albuminoid ammonia in sea water should be the same as that observed in the increase of these constituents in the well water. To determine whether this was the case, a sample of sea water was obtained from Lavender Bay at high-water spring tide, and was found to contain 1,369 grains of chlorine per gallon. Now, to obtain an increase of chlorine from 16·18 grains per gallon (the contents of the Sugar Company's water when first obtained) to 21·05 (the average of the water on steady pumping), would require 1 part of sea water to 228 of the original water; 2 c.c. therefore of sea water was added to 456 c.c. of Sydney water, and the free and albuminoid ammonia determined in the mixture, with the following result:—

Free ammonia in mixture ...	0·12	parts per million.
Less amount in Sydney water	0·01	„
	0·11	„
Free ammonia in well water of June 26th, 1877 ...	0·27	„
	0·38	„
Average of six determinations, in March and April, 1878, in water from bore...	0·325	„
Albuminoid ammonia in mixture	0·48	„
Less amount in Sydney water	0·08	„
	0·40	„
Albuminoid in well water in June 26th, 1877 ...	0·01	„
	0·41	„
Average of six determinations, March and April, 1878	0·397	

These results show a surprising agreement; a repetition gave concordant figures, and calculation shows a perfect agreement in the case of the water from the Standard Brewery.

The total increase of chlorine in the Sugar Company's water is 4·89 grains per gallon, with a total increase of ammonia of 0·142 parts per million, so that the increase of 2·05 grains of chlorine per gallon in Messrs. Toohey's water should increase the total ammonia by 0·18 parts per million, whilst the actual increase is 0·17 parts, or within the limits of experimental error on a single distillation.

The large quantity of albuminoid ammonia yielded by sea water (87 parts per million) is doubtless largely due to the immense number of microscopic organisms contained in it, and these could only reach the bores if the water flowed in fissures. If the water percolated through a porous bed, many of these organisms would doubtless be retained during the filtration, and the close agreement found in the experimental trials would not exist. The fact that the water-level now remains so many feet below its original height militates against the above hypothesis, and is not easy of explanation in any way unless the original outlet is getting slowly silted up, in which case we might expect the water to return to its original condition; but up till now (30th September) this has not occurred. The water, being originally higher than sea-level, would only represent the *head* required to cause the water to flow along a fissure probably some miles in length.

Everthing indicates, however, that no great underground supply of water is available in this neighbourhood, and it will be observed that the total quantity of solid matter in solution increases with the depth. Thus, deducting the oxide of iron found in the bore-waters as accidental, the total solids are—

Sydney water	... ...	3·74	grains per gallon.
Surface spring	... ...	6·46	,, ,,
Standard Brewery,	180 feet	24·22	,, ,,
,, ,,	380 ,,	32·55	,, ,,
Sugar Company,	427 ,,	45·45	,, ,,

This considerable increase of salts in solution would be objectionable for most domestic purposes, and probably on boring deeper the waters of the coal-beds would be obtained. These waters in this country are generally charged with mineral matter, so much so as to render them useless, so far as they have

come under my observation. For example, three different waters from the mines of the Australian Agricultural Company at Newcastle gave—

No. 1.

Oxide of iron	3·01	grains per gallon.
Alumina	9·35	" "
Lime	8·18	" "
Magnesia	2·55	" "
Chloride of sodium	8·48	" "
Sulphuric oxide	45·80	" "
Phosphoric "	traces	
Silica	2·46	" "
Loss on ignition	51·26	" "
Total solids	131·09	" "

of which 5·45 grains was insoluble after evaporation.

No. 2.

Alumina	40·70	grains per gallon.
Lime	4·37	" "
Magnesia	4·38	" "
Chloride of sodium	23·54	" "
" potassium	traces	
Silica	0·90	" "
Sulphuric oxide	110·40	" "
Phosphoric "	traces	
Loss on ignition	82·83	" "
Total solids	267·32	" "

of which 13·99 grains were insoluble in water after evaporation.

No. 3.

Alumina	10·28	grains per gallon.
Lime	12·98	" "
Magnesia	19·19	" "
Soda	13·70	" "
Potash	traces	
Chloride of sodium	8·86	" "
Silica	4·54	" "
Sulphuric oxide	99·99	" "
Phosphoric "	traces	
Sulphhydric acid	0·05	" "
Loss on ignition	99·31	" "
Total solids	268·90	" "

of which 29·45 grains were insoluble after evaporation.

Discussion.

The Rev. J. E. Tenison-Woods asked if any record was kept of the character of the strata passed through in the boring.

Mr. Dixon said that as the borings were done with the ordinary boring tools the rock was all crushed, and therefore samples would not be of so much value as by the improved methods, and he did not know whether samples had been kept by Mr. Poolman.

Mr. Poolman said that when he arrived the boring was down 100 feet and no samples had been kept, but from that depth he had samples in his possession. At 100 feet the rod passed through a bed of soft sand, and they fully expected to obtain water there, but did not. At the greater depth the rock had much the appearance of Bath-brick.

Mr. Henry had examined some of the samples brought up at the Newington boring, and found them to be carboniferous sandstone. He did not like to hear of so much total solids in the brewers' wells or the idea of drinking beer "*cum grano salis.*" he considered it probable that springs rose at Botany.

Mr. Dixon said that the fault of all the water obtained here for brewing was that it did not contain enough solid matter in solution. The water at Burton-on-Trent contained about 78 grains of total solids per gallon, and the waters used for brewing the best beers in England varied from 60 to 80 grains per gallon of total solids.

The Rev. J. E. Tenison-Woods said he had seen carboniferous fossils brought up by the borings at Newington, but he did not know whether they had come on good water. He would like to know what the character of the water at Newington was, as found in the coal borings.

Mr. Dixon said that he had not seen any of the water from the coal boring at Newington, but in all cases which had come under his observation the deeper they sunk the harder the water became, until the waters of the coal measures were so charged with solids as to be unfit for drinking purposes. This was however not universal, as the town of Rutherglen, in Scotland, was supplied with water pumped from a coal-pit.

The Chairman asked if it was Mr. Dixon's opinion that Botany was simply a watershed, or were there springs there.

Mr. Dixon believed that Botany was simply a watershed. The spring waters were all so much harder than the Botany water that if any of the Botany swamps were supplied from an underground source the water would have become much harder during the drought of 1876, when the waterworks were severely taxed, but this had not been the case.

Note on Huan Island Guano.

By W. A. Dixon, F.C.S., F.I.C., Lecturer on Chemistry, Sydney School of Arts.

[*Read before the Royal Society of N.S.W.*, 4 *December*, 1878.]

In a paper which I read before the Society on the guano deposits of Malden Island, and which was published in the Society's Journal, Vol. XI, I observed that the deeper layers of guano were invariably richer in calcium phosphate than those nearer the surface, and that although I had made numerous experiments I was unable to account for this difference. I have lately had a number of samples of guano from the Huan Islands, which lie to the north of New Caledonia, and they appear to throw some light on the subject.

These samples of guano were from the surface, and, although phosphatic, are characterized by containing a much larger proportion of organic matter than is usual in this class. The organic matter ranges in many of the samples between 20 and 25 per cent., and although somewhat nitrogenous it is evident that much of it is of vegetable origin—all the samples contained carbonate of calcium varying in amount from a little over 2 to 10 per cent.; and it is therefore surprising to find that in most cases they have a strongly acid reaction, and that this is due to free phosphoric acid or acid calcium phosphate.

The guano effervesces slightly on the addition of water, and it was therefore attempted to get rid of this action of the acid on the carbonate of calcium by treating with dilute carbonate of ammonium, the phosphoric acid being determined in the solution, which was of a dark brown colour. It was found, however, on adding magnesia mixture to the solution and allowing it to stand, that dark warty crystals were deposited with the ammonio magnesian phosphate. These proved to be the magnesium salt of some organic acid, as on treating the ignited precipitate with sulphuric acid and re-igniting, its weight was more than doubled, from the formation of magnesium sulphate.

It seemed probable that the crystals might be one of the ammonio magnesian oxalates, as oxalate of ammonia occurs in Peruvian guano, and I had observed that the tissues of some of the plants growing on a guano island were loaded with raphides of calcium oxalate. On adding to a similar solution, however, chloride of calcium, and acidifying with acetic acid, a light flocculent precipitate only was obtained readily soluble in ammonia.

The amount of carbon dioxide evolved from the ash of the guano was also found to be slightly greater than that from the guano itself, showing the presence of an organic calcium salt. Thus, three samples gave as the mean of several closely approximating determinations:—

	No. 1.	No. 2.	No. 3.
Carbon dioxide in the ash calculated as original guano	4·57	1·54	1·50
Carbon dioxide in the raw guano ...	4·17	1·27	1·12

The limited quantity of material at command has prevented further research on this point for the present.

As the carbonate of ammonia method failed, portions of the guano were mixed with a little hot water, transferred to a filter and rapidly washed with successive small quantities of hot water, the total washings being about 75 c.c. for 5 grm. The solution was slightly yellow only, and was treated with oxalate of ammonium and acetic acid to remove a trace of calcium, and the phosphoric acid determined as magnesium pyrophosphate with the following results from different samples, the first three being from one island and the other two from another, the total phosphoric acid and carbonate of calcium calculated from the carbon dioxide being also given:—

	Total Phosphoric Acid. P_2O_5	Soluble Phosphoric Acid.	Calcium Carbonate.
No. 1	29·96	0·18	9·47
2	31·68	0·53	2·88
3	31·57	0·44	2·54
4	32·14	0·42	2·47
5	34·63	0·63	2·29

It appears as if the organic matter protected the calcium carbonate to some extent from the action of the phosphoric acid, so that it may be washed out, and thus occasional showers of rain would carry it down into the lower layers of the guano beds where the organic matter has been removed by slow oxidation, and there convert the carbonate into phosphate. As each successive layer of guano passed through this acid stage in the gradual decomposition of the organic matter and passage from a mixture containing much organic matter a small quantity of calcium phosphate and a still smaller quantity of calcium in organic combination to its residual form of phosphate and carbonate of calcium, the layers below would thus continually become enriched in phosphates. The small quantity found cannot be taken as a measure of the total acid available, as it is probably confined to a thin layer at one time, with which other layers had been mixed in the samples examined.

The Rise and Progress of Photography.

By Ludovico W. Hart.

[*Read before the Royal Society of N.S.W.*, 4 *December*, 1878.]

In glancing through the world's history, from the early ages down to the present time, we find that each age or epoch has been marked by one or more discoveries or inventions, that have called forth the energy of clever and refined minds, which have served to benefit the great family of nations; and as age has succeeded age, so great and important discoveries have succeeded each other, each one vieing with the other in importance and magnitude, and so beautifully and wisely have these taken place, that as one has become old by the difference of the age and the requirements of time, another springs up and fills its place; thus does nature, constantly in her own way, and by her own means, keep up a regular supply of what is good and beneficial to man.

Now among those that have characterized the present century, there are few, if any, that have been of more service, or are more deserving of our gratitude, than that of the invention of photography. Sure and marvellously rapid has been the progress of this art-science, and like steam and electricity it soon found its way round the globe, and I think I may safely say that it has been at work in many places where the other two have not as yet appeared.

Nor is its influence less than its greatness; morally, artistically, scientifically, and commercially, it has opened a new epoch in the history of the world's knowledge, and although great were the hopes of its originators, I can scarcely imagine that they could have foreseen the future importance of their great discovery. A discovery is valued according to two things, its artistic or scientific value and its commercial value; both these things are considered of importance—the one giving knowledge and the application of that knowledge; the other concerns all the daily intercourse and workings of the great human family. As to which of the two is more conductive to our welfare is not in my programme, but an invention combining the two is certainly deserving of our warmest support. Such then is photography; there is no branch of knowledge that does not gain by it. Art is even guided by it, however much the fact may be disputed and denied. Science accepts it as a most perfect exposition of her truths, and in the hundred and one phases of daily life we find her playing a prominent and important part.

I propose dividing my paper into two parts—firstly, the history and progress of photography; secondly, its practice and applications. In tracing to its abstract the history of any great discovery which has not been sudden or fortuitous, but which has been gained by deep study and oft repeated trial, we find two prominent things, the idea that caused the wish, and the means for the perception of the fulfilment of that wish.

The one is the essence and the other the substance, and they are as important to each other as soul to body. These are represented by certain substances which have from time to time been noticed to darken under the influence of white light, and the camera obscura aided by chemical and optical research. We will now see how photography came into existence and to whom we are indebted for our knowledge in its present advanced state.

Assertions have from time to time appeared in print crediting both the Chinese and Japanese with having possessed the knowledge of photography; others have given the ancient Egyptians the place of honor, as being the first to employ the salts of silver in making sun pictures, and it seems pretty certain that they employed it in some of the paintings on the cloths wrapped round their mummies. We will, however, leave these uncertain theories and go back about three hundred years. The alchemists certainly knew of the existence of chloride of silver, as verified by Fabricius about the year 1566 in his work "De rebus metallicus." Again we find it in a very singular work by Tephaigne de la Roche, entitled "Giphantie à Babylone," who supposed himself transferred to the palace of the genii of the element, the chief of whom thus addressed him:

"You know that the rays of light reflecting various bodies paint them on the retina of the eye, on the surface of water, and on mirrors. The spirits have sought to fix these images; they have composed a very subtle adhesive material which hardens very quickly, by means of which a picture is made in the twinkling of an eye. They spread this substance on a piece of cloth and expose it to the object they wish to depict. The first effect of this prepared cloth is that of a mirror, near and distant objects being shown upon it, but that which a glass cannot effect, this cloth with a viscous covering does, namely, it retains the image faithfully. It is taken away directly to a dark place, and an hour after you have a picture far more precious, truthful, and lasting than any that art can produce. The spirit then entered into a physical disquisition, first on the nature of the glutinous body employed; secondly, on the difficulties of preparing and employing it; and thirdly, on the mutual action of the light and glutinous body, three problems," adds Tiphaigne, on waking from his trance, "I propose to the philosophers of our days."

Both England and France have laid claim to be the cradle of this giant baby, and both countries have about the same claim to its rapid development, for although France has the honor of having brought most of the experiments, both in its earliest and later stages, to a practical issue, yet the names of Herschell, Wedgewood, Davy, and Fox Talbot will always hold a prominent place wherever the history of photography is proclaimed.

The mention of the principles of the camera obscura or dark chamber is the earliest reliable record we have concerning the future discovery of the invention of photography. It was discovered in 1544 by Giovani Baptista della Porta, a Neapolitan monk, who on seeing the objects from without reflected upon the white walls of his cell through a hole in the shutter, became the means of giving to the world a pleasing and as it has since proved a valuable instrument.

The next thing we have record of is the chloride of silver, called by the alchemists "horn silver" from its peculiar appearance. This mineral is still occasionally found in some parts of Germany, and has a vitrous dull shining aspect, white in colour, which changes rapidly to violet on exposure to white light. In 1777, just 233 years after Porta's discovery, the learned Scheel, a native of Sweden, experimented with this substance in another form, and remarks that paper prepared with chloride of silver and exposed to light turns dark, and accordingly produced many copies of drawings by contact; he likewise was the first to call attention to the fact that paper prepared with nitrate of silver and exposed to the solar spectrum, by passing a beam of light through the prism, that the action was greatest at the blue end of the spectrum, and that it even went beyond the visible spectrum, whilst no change took place in the green, yellow, orange, and red portions. Priestly and Senebier also experimented with the nitrate and muriate of silver, for making pictures and writing on glass with the aid of the sun; this does not seem to have excited more than a momentary curiosity, for it was not until the year 1802, in the month of June, when we find in the journal of the Royal Institution "An account of the method of copying paintings upon glass and making profiles by the agency of light," by Thomas Wedgewood, Esq., with notes by Mr. H. Davy, afterwards Sir Humphrey Davy. Here again it was nitrate of silver used. Fac-similes of these light pictures, which were called heliotypes, still exist, and further research into the doings and experiments of Wedgewood guarantee the fact that as early as 1791 he was experimenting with one, a Monsieur Daguerre, who died between 1798 and 1802, poor and very much in debt; this however was not the Daguerre destined to become the discoverer of the process bearing his name but his father, and the Wedgewood mentioned was the son of the

great Josiah Wedgewood. Wedgewood and Davy became great friends, and for some time continued their researches together. They produced many beautiful copies of drawings, leaves, lace, and such like things, but alas, their beautiful discovery was only of partial value, for a new difficulty now presented itself: the beautiful pictures obtained with so much trouble and patience when exposed to daylight gradually darkened all over.

We must now pass over a few years, during which time we occasionally hear of various experimenters using the different salts of silver as their predecessors had done; among them may be mentioned Seebeck, Guy Lussac, Draper, Ritter, and Wollaston.

In 1814, we find the celebrated Niépce likewise engaged in prosecuting a series of studies in this new light process, and about twelve years later we hear of him engraving by the same process; to do this he prepared metallic plates by coating them with asphaltum, and then exposed them to light in the camera obscura; where the light had acted upon the asphaltum it became insoluble, whereas the shaded parts were washed away with oil of lavender, which left bare the metallic surface of the plate, and which was then etched. In 1824 Louis Jacques Daguerre, the inventor of the diorama, experimented also upon the nitrate and chloride of silver, employing the camera obscura, and striving to fix the pictures so obtained. In 1827 Niépce was introduced to Daguerre, and for some time kept up a regular correspondence which ended in a partnership; we now find the latter neglecting altogether his diorama painting and closely studying chemistry. It was while pursuing those studies that he observed the curious fact that a silver spoon he had left on a metal plate previously treated with iodine, had left its impression clearly on the metal surface; this he further developed with oil of petroleum. Shortly after this, about 1833, Niépce died and left Daguerre to solve alone the problem of the process called after him. I may as well state here in what consisted his invention: He exposed a highly polished silver surface to the action of iodine, and after exposure to light to bring out the latent image by development with petroleum. He continued toiling along, looking for a more active and convenient means of development, until an accident greatly assisted him. Having prepared as usual some plates and exposed them to light, he placed them away in a cupboard for a short time, being called away and intending to develop them on his return; but what was his surprise and joy shortly afterwards on returning to his cupboard to find his plates fully developed, and having a perfect image upon them. He imagined at once that the impression must be due to some chemical or other in the cupboard. He therefore took the chemicals away by degrees, still preparing and exposing plates, and placing them in what he

called his magic cupboard, one and all of them became developed; at last all the chemicals were removed. In a fever of anxious excitement he again prepared and exposed some plates and put them in their usual place, and on going a few hours later, imagining to find them still in their latent state, lo! they also were fully developed. Mystery of mysteries! but soon to be cleared up; for on a close examination of the magical cupboard he found a small dish containing mercury that had escaped his notice. Other plates were quickly prepared, exposed, and put in the cupboard; result, the same. Thus mercurial vapour became the recognized medium for development in this process.

The news of his discovery soon spread, and Humboldt, Biot, Arago, and others became his confidants. After much persuasion and delay he consented to give his discovery to his country in consideration of a yearly pension of 4,000 francs, and on the 19th of August, 1839, at the memorable *séance* public of the French Academy of Science, in the Palais Mazarin, Daguerre illustrated his process by development. As might be expected, the news of this wonderful process of picture-making had been spread abroad, and on this occasion the *séance* was attended by all the *élite* of art, science, and even diplomacy, resident at that time in Paris. Arago, in his opening speech, says, "France has adopted the discovery and is proud to present it to the whole world." In a number of the *Moniteur Universel* about that date it is thus spoken of:—"After years of patient research, of disappointment, and hope almost crushed, Monsieur Daguerre has succeeded in fixing the natural light on a solid substance, in giving a body to the impalpable and fugitive image of objects reflected in the retina of the eye, in a mirror, in the apparatus of the *camera obscura*."

It need hardly be stated that from all parts of civilization came disciples to Daguerre. Morse, of America, and Sachse, of Berlin, were among the first to take it up. Professor Draper joined Morse, Claudet came to London, and Goddard, Blake, and others commenced practising in different parts of England. Daguerre had constantly been asked to make his process known before he did, but his reply was always the same: "When I have so perfected it as to allow others to work it as easily as myself, I will then make it known, and not till then." Now these pictures were very slow, and when required for portraiture the sitters were obliged to be placed in the sun; hence the unpleasant expressions so often seen in the early specimens of the process.

To give you some idea of the patience required in posing in those days, I have taken an extract from Gaston Tissandier. He says:—"The model took a graceful attitude, resting one hand on the back of a chair, and looking as amiable as one could do

with the sun full in his face; the operator gives the final warning to be still. The seconds pass—succeed each other—and seem to expand into centuries. The sitter (or as he ought now to be called the "patient"), in spite of all his efforts, is overpowered by the solar rays; the eyelids open and close, the face contracts, the immobility to which he is constrained becomes at last a torture; his features shrivel up, tears fall from his eyes, perspiration breaks out from his forehead, he pants for breath, his entire body shakes like that of an epileptic who wants to keep still, and the Daguerreotype plate represents the image of a poor wretch who is undergoing the torture of ordeal by fire."

Shortly after its publication, Goddard added bromine to the iodine, which greatly accelerated its effect; and Claudet finally added chlorine. Better lenses were also speedily manufactured, the best of which were those by Professor Petzval, manufactured by Voightlander, who became celebrated for his now-called photographic lenses. These, however, have in their turn been superseded by those of Lerebours and Secretain, Chevallier, Ross, and Dallmeyer.

While these great events were going on in France our English investigators had not been idle, for we find that Mr. Fox Talbot had been working silently for some time with the silver salts. For the carrying out of his particular process he used to prepare his paper by immersing it in a solution of common salt, and when dry in another of nitrate of silver, thus obtaining the chloride of silver as a medium for his impressions. He found that the paper so prepared was much more rapid in its action than that by Wedgewood and Davy; but like them, the pictures so obtained soon became dark and useless. He tried to fix them by plunging them into a hot solution of salt, but this only partially succeeded; and it is to the eminent English astronomer, Herschell, that we are indebted for the introduction of a substance answering all the wants in this direction, and which is used to this day—the hyposulphite of soda. He also introduced many interesting processes that are out of date now. The chemicals employed by him were the ferricyanide of potash, ammonia, citrate of iron, and the ferro tartrate of silver.

The scientific world had by this time become thoroughly interested in these photographic experiments. Pictures were regularly taken by the Daguerreotype, Talbotype, and other processes. The negative process on wax paper had been clearly demonstrated, but many anxious experimenters were held back by the patents held by Mr. Talbot, and the formation of a Photographic Society was for a time prevented. These patents were, however, eventually withdrawn, as will be seen by the following letters. The first is from the Presidents of the Royal Society and the Royal Academy, and appeared in the *Times*, August 13th, 1852, after an

unsuccessful attempt by Mr. Talbot to bring an action against Messrs. Scott, Archer, and Gustave le Grey, the inventors of the collodion process; the second one is his reply. We will begin with the first:

"The art of photgraphy on paper, of which you are the inventor, has arrived at such a degree of perfection that it must soon become of national importance; and we are anxious that as the art itself originated in England, it should also receive its further perfection and development in this country. At present, however, although England continues to take the lead in some branches of the art, yet in others the French are unquestionably making more rapid progress than we are. It is very desirable that we should not be left behindhand by the nations of the Continent in the improvement and development of a purely British invention, and as you are the possessor of a patent right in this invention, which will continue for some years, and which may perhaps be renewed, we beg to call your attention to the subject, and to inquire whether it may not be possible for you by making some alteration in the exercise of your patent rights to obviate most of the difficulties which now appear to hinder the progress of the art in England. Many of the finest applications of the invention will probably require the co-operation of men of science and skilful artists, but it is evident the more freely they can use the resources of the art the more probable it is that their efforts will be attended with success, and, as we feel no doubt that some such judicious alteration would give great satisfaction and be the means of rapidly improving this beautiful art, we beg to make this friendly communication to you in the full confidence that you will receive it in the same spirit, the improvement of art and science being our mutual object.

"Signed—Lord Rosse and Sir Charles Eastlake."

Mr. Fox Talbot's reply was as follows:—

"I am as desirous as any one of the lovers of art and science whose wishes you have kindly undertaken to represent, that our country should continue to take the lead in this newly discovered branch of the fine arts; and after much consideration I think the best thing I can do, and the most likely to stimulate to further improvements in photography, will be to invite the emulation and competition of our artists and amateurs by relaxing the patent rights that I possess in this invention. I therefore beg to reply to your kind letter by offering the patent (with the exception of a single point, hereafter mentioned) as a free present to the public, together with any other patents for improvements in the same art. The exception to which I refer, and which I am desirous of keeping in the hands of my own licensees, is the application of the invention for photographing for sale to the

public; this is a branch of the art which must necessarily be in a few hands. With this exception then, I present my invention to the country, and trust that it may realize our hopes of its future utility.—Fox Talbot."

The exception to which Mr. Talbot referred fell through at once, as the advance of photography was so rapid that other improvements soon left his original process in the background. Paper, although a convenient, was nevertheless a defective medium; it is true it had not the unpleasant mirror-like glare of the silver plate, but then the texture was not all that was required; its fibrous nature gave oftentime much trouble; it did not absorb uniformly the liquids required, and had many other little inconveniences. It was while our early workers were in this trouble that a nephew of Niépce, named Niépce de St. Victor, came upon the scene and added another name to the already host of inventors or improvers of photography. This gentleman had been a student at the military school of Saumur, and became Lieut. of Dragoons in 1842; it was at that time he began to study seriously scientific pursuits. He soon found, however, that a provincial town afforded him very few chances for becoming known to the men of the day, and accordingly got transferred to the Paris Municipal Guard. It was in the gay capital, in a small room belonging to an under officer of police, that he pursued under great difficulties his various studies and very interesting experiments; for it is not to be wondered at that he followed in the footsteps of his uncle, and in 1844 used glass as a support for the substances he employed to hold the silver salts, which at that time was starch, subsequently abandoned for albumen about the year 1847. Albumen was considered a perfect medium for the salts of silver until another happy application took place. In 1846, Schœnbier announced his discovery of gun cotton. Le Grey, Archer, and Fry at once saw hopes of utilizing the new material, and after many trials and failures, Scott Archer succeeded in introducing it and brought out his collodion process. Le Grey in France had also been rewarded with success in the same direction.

This discovery opened a new and brighter epoch than had as yet dawned upon the now army of photographers; this process is a perfect answer to all the requirements of the most sanguine photographer, for from the date of its first appearance to the present day it has never ceased to prove itself to be the greatest boon we have yet received, and allowed the invention of photography to be advanced to a degree of perfection hitherto unthought of.

It was my intention to omit any matter relating to the practical part of photography, but the importance of this process calls for a passing and short notice of its *modus operandi*. We

will begin with the gun cotton. This substance is procured by saturating ordinary cotton wool, certain fibrous woods or paper, in a mixture of nitric and sulphuric acids, after which it is well washed to free it from all traces of acid and allowed to dry. It is then dissolved in a mixture of alcohol and ether, and forms a glutinous solution of the consistency of oil; certain iodides and bromides are now introduced into it, and it takes the name of iodized collodion. This being poured on a glass plate is allowed to evaporate, which it does rapidly, until it is set and forms a film and is then plunged into an aqueous solution of nitrate of silver. The iodides and bromides now combine with the silver and form by double decomposition an iodide and bromide of silver with an excess of nitrate of silver in solution. This plate is then exposed to the action of light in the camera obscura, when a latent image is formed, which is developed or brought out by the action of proto-sulphate of iron or pyrogillic acid; the unaltered iodide of silver is then dissolved away by means of cyanide of potassium or hyposulphite of soda.

Perfect negatives being now easily procured it became necessary to use another and more perfect paper to receive the positive image. A smooth and finely grained paper was chosen and prepared by laying on its surface a solution of albumen in which was deposited a chloride; when dry this was floated on a solution of nitrate of silver, forming a chloride of the same salt. After again drying it was exposed behind a negative; gradually the exposed parts became changed in colour, turning first violet or pale reddish brown according to the chloride used, gaining in intensity as the light acted upon them, and finally becoming almost bronzed in the perfectly transparent parts of the negative.

These prints are now toned in a solution of chloride of gold and fixed in hyposulphite of soda; these are called silver prints, and the process is the one in actual use where only small numbers of proofs are required.

One would naturally imagine that all the trials and uncertainties had been now overcome, and that nothing remained but to work and multiply; so it was for some time thought, but soon came back the ghost of past days, and it was found that these beautiful proofs were not permanent. A variety of causes made them uncertain, and one is never sure of having a silver print that will not either fade or turn yellow; some have retained their brilliancy for many years, and we have specimens made in the early days of albumenized paper looking as fresh and pure as when first produced, but they are the exception and are very, very few in number.

This indeed was a serious drawback in the now advanced stage of photography, but progression, the natural order of things, brought its powerful aid, and as trouble and uncertainty came

upon us so also came the means of preventing them; and if the early investigators of photography laboured hard to overcome their difficulties, their earnestness and good example has been nobly taken up, not by one, but by a legion, to save this beautiful and valuable aid to art and science from the stigma of being but a fading record.

Two things seemed now to be required to complete photographic printing, printing in natural colours and permanent prints. The former may yet be a long way off, but the experiments of Bèquerel, Niépce de St. Victor, Vidal, Woodbury and others, have so far succeeded that for commercial purposes there are already three processes in use. We turn to the latter requirement and find that success has bountifully rewarded the many patient months and years of trial in this direction, for photography which has already in many cases supplied the place of the artist or designer, has now allied itself to the printer, and photo-mechanical printing has now become a practical fact, is in use all over the civilized world, and I think the day not far distant when large printing establishments will not be considered complete without a photographic branch. The advantages derived from these processes are permanent impressions, rapidity of printing, printing independently of white light, perfect equality in the tone and value of the proofs, printing in any colour desired, cheapness, with the correctness and perfection of outline, detail, &c., generally found in photographs. No remarks need follow these advantages to show the immense utility of such processes, but a short extract from an article in the London *Times* on the value of the reproductions of the pictures of the great masters would not be *mal à propos*:—

"If pictorial art, is, indeed an educational influence of a high order, and if it is desirable to keep beauty of form before the eyes of the young, the autotypes (mechanical prints) of the great masters should not only find the places of honor of which they are well worthy, but they should be in every nursery and schoolroom in the kingdom."

This is only one application for them; there are astronomy, botany, geology, ethnology, jurisprudence, and a hundred other ways of using them. But I must leave these for the present and introduce to your notice the various processes of permanent photo-mechanical printing. I have thought it not out of place to include a very valuable and beautiful process, which although not mechanical is nevertheless a permanent printing process, and in point of value is not the least among them. I refer to the Carbon process, or as it is called in Great Britain "Autotype," which is simply the production of pictures by the means of light and chemical action upon gelatine and permanent pigments, such as are used by artists in oil, water colour, or crayon drawings.

The rationale of the process is this,—that bichromate of potash, in conjunction with gelatine, albumen, gum, &c., when dry becomes decomposed and insoluble in hot water when acted upon by light, whereas it remains unaltered in those parts not subjected to light, the action that takes place is "that gelatine, aided by light, reduces the chromic acid of the bichromate to a lower state of oxidation, then enters into a combination with a compound of chromic acid, produced by a mutual decomposition of chromic acid and gelatine, the original being the formation of a leather-like substance, insoluble in hot water."

The first person who observed this action was Mungo Ponton; Monsieur Bequerel found that sized papers aided the result, but it was Poitevin who discovered the important fact that if a pigment were added to the gelatine and bichromate of potash and then dried and exposed to light, the pigment became entangled in those portions of the gelatine rendered insoluble by the light, and could not be washed out again. In this and various other interesting experiments he may be said to have been the father of all the various processes having for their base bichromate of potash and gelatine.

A paper prepared with a coating of these substances and exposed to light behind a negative in cases of line subjects, where the action had been continued sufficiently long to traverse the gelatine coating and reach the paper, all was good so far as washing away the insoluble parts was concerned, but the image thus obtained was reversed, and when subjects in half tones were tried it failed, as the action taking place from the outside portion of the paper the half tones would be washed away in the subsequent treatment, as they rested upon a substratum of the compound entirely unacted upon by light. To remedy this, the Abbé Laborde, in France, and Mr. Blair, in England, spread the compound upon glass and transparent paper, printing the picture through the transparent medium, and, after the necessary exposure to light, washed away the soluble portions of the compound, leaving the insoluble picture firmly attached to the glass or paper. This was a step in the right direction, and was soon followed by others of importance, notably by Swan, of Newcastle, who spread his sensitive compound upon glass previously coated with collodion; in this manner he was enabled to separate it from the glass, expose it to light, and remount it again for development. This he called the tissue, and afterwards greatly improved upon his process by making his support of paper. After many important improvements and the establishment of the single and double transfer, Mr. R. Sawyer, in 1874, introduced his flexible support for the purpose of allowing the development of a carbon print on a soft film of an insoluble nature, and afterwards transferring it to any other

body, such as paper, glass, wood, porcelain, ivory, &c., &c.; thus the image is no longer reversed, but seen in its right position. The process as it now stands may be described in a few words:—A paper is coated with gelatine and pigments, sensitized in a solution of bichromate of potash, dried and exposed behind a photographic negative; those parts affected by light become insoluble in the development, whilst the soluble portions are washed away and form the whites of the picture; the half-tones remain more or less insoluble, according to the amount of light received through the negative; the development is effected by warm water; the print is then passed through a solution of alum, washed and dried.

The first process of photo-mechanical printing that I shall speak of is photo-lithography. Among the early records of the process we find by a letter from Monsieur Lacon in December, 1874, that a modest lithographic printer as far back as 1842 produced, by means not known, or then forgotten, many beautiful photographic impressions on stone; he worked quietly and unheeded in his leisure hours, and to the fact of his great modesty and humble position we owe the misfortune of not being acquainted with his process. I merely mention this fact, *en passant*, in order to render honor to whom honor is due, for of all the many treatises published on these processes only one does justice to the memory, or even mentions the early labours of the workman Zurcher. About the year 1852 we find three French gentlemen, Lemercier, the head of a large and well known printing establishment in Paris, Lerebours, the optician, and Davanne, the chemist, using bitumen dissolved in ether. They coated a lithographic stone with this solution, dried it, exposed it to light behind a negative, and subsequently washed it in ether; those parts affected by light remained on the stone insoluble, and the non-affected parts were washed away by the ether; the stone was now gummed and acidified and rolled in like an ordinary lithographic stone. In 1860 Monsieur Poitevin issued a book of instructions for this process; he also coated a stone with a compound capable of being acted upon by light, but employed gelatine, starch, gum, and albumen, rendered sensitive by the bichromate of potash; thus up to this day all the so-called inventors of new photographic processes have simply been using modifications of Poitevin's process, inasmuch as these substances became and still are the recognized media for the proper carrying out of photo-lithography. Among the many modifications may be mentioned, Asser of Amsterdam, Colonel Sir H. James, Newton, and Osborne, in England, Simonau and Toovey of Bruxelles, Captain Waterhouse, in India, and many others.

Asser used starch spread upon paper and sensitized with bichromate—the latter substance being the salt used by all for

this purpose. After exposition to the light, he put the print into cold water to soak away all the unaltered bichromate, inked in with a peculiar roller and a thin transfer ink mixed with ordinary printing ink. This formed the transfer ready to be put upon stone and treated in the ordinary manner.

Simonau and Toovey used gum in the following manner:—A paper is floated upon a solution of gum and bichromate, dried and exposed behind a negative; by a peculiar process the unaltered portions of the gum are pressed into the stone, leaving the lines bare; the light having acted upon these parts, has rendered them insoluble; a roller is now charged with ink and passed over the stone, which only takes the ink in the uncovered parts. One peculiarity in this modification is that the stone is not acidified as in the others.

All the rest use gelatine, gum, or albumen, either alone or combined, and use warm water and a fine sponge to remove the ink and gelatine from the unaltered portions of the transfer; but were I to give you an epitome of the many ways of working out this process I should occupy you for some hours. Photo-zincography is another form of photo-lithography, using a zinc plate in place of a stone. We will now pass on to photo-typography, which consists in preparing a metal block by photographic means to be used in ordinary printing with text. There are two principal ways of doing this—by biting in with acid, or by making a gelatine relief and taking casts of it afterwards, to be treated by electrotyping. In the first case a transfer from stone is laid down on a zinc plate; or the plate may be prepared with bitumen and exposed to light, and then treated with a weak solution of nitric acid; great care is required in keeping the lines good, as they are formed by the biting in, it being necessary to re-ink frequently the image, and to add powdered resin, so that by a gentle application of heat this composition gradually falls over the sides of the lines formed, and protects them from the action of the acid employed in biting in deeper.

In the other case a gelatine relief is made from which is taken a plaster cast, or one of wax and stearine, which is then treated by the electrotyper; this process like that of photo-lithography is employed for line subjects, or anything in black and white; half-tone may be procured, as you will see by some of my specimens; but unless printed by men especially kept at that work, the fine details soon become choked up, and the block rendered useless. This process is largely employed in Europe and America, and I find with pleasure that it is now introduced into one of the leading printing firms in this city. Another process, allied to the former ones, is that called heliography, and sometimes heliolithography; here a glass is covered with a suitable substance, and when dry is engraved by an artist by means of a

needle point; very beautiful designs and effects are produced by these means, and one of the chief uses consists in the fact that an artist on the staff of an illustrated newspaper takes out with him in place of his sketching materials a small number of these prepared glasses; he engraves them on the spot almost as rapidly as drawing them, sends them home to the photo-mechanical operator, who in a few hours produces a perfect matrix to be electrotyped for printing with the text, or photo-lithographed if required to form a collection, or, if preferred, a copper-plate made for printing as engraving. This process is really very useful and advantageous, as the cost is regulated by the size of the plate, and not the amount of work upon it; thus a most complicated plate costing perhaps £20 or £30 sterling to engrave can be done for £2 or £3.

The next process I shall speak of, is that known as the "fatty ink process," or more familiarly the "Albertype" "Heliotype" "Obernetter process" or "autotype mechanical process." All these are one and the same process, the same result being arrived at by different formulæ, and are all based on the early experiments of Poitevin and Tessié de Mathey. A glass or metal plate is coated with gelatine and sensitized in the usual way; when dry, it is exposed behind a negative, until all the details are visible; it is now placed in cold water, when it will be seen that the portions of the plate that have been protected from the light are slightly in relief, having swollen up by taking a part of the water, those portions that have been fully exposed to the action of the light, and consequently changed into a leather-like substance, refuse the water; the half-tones take moisture in proportion as they have been more or less shaded from the light. When all the free bichromate has been washed out the plate may be left to dry or inked up at once in the following manner: A roller is charged with rather stiff lithographic ink and passed over the plate as over a stone. It will be observed that all the darkest parts of the image take kindly to the ink, whereas the portions holding the water quite refuse it, the half tones taking little or nothing from the stiff ink. If now another roller be charged with a thinner ink, and the same plate is again rolled with it, all these half-tones will soon appear in their relative force, and the plate is ready to be printed. This is done in an ordinary Albion press, and when taken from the press is ready for binding, having a margin all round it. Here we have a perfect photograph, possessing all the delicate tones of the negative, in ordinary printers' ink, which is consequently as permanent as the most fastidious person can desire. You will perceive that this process is strongly allied to lithography, inasmuch as in the printing it has to be treated in almost the same way as a lithographic stone. There is however this difference: The

litho. stone absorbs water in every part of its surface whereon an image in lithographic ink has not been previously produced, but it has no graduated capacity of absorption, the slightest touch of a fatty matter will cause the stone to repel water and take the ink; but where the stone is clean and no part of the image is, it absorbs water completely and repels the ink, whereas these processes possess a "discriminative power of absorption," and that not only to quantity but to the consistency of the ink taken up by various parts of the plate. To harden the gelatine in order that it may not get worn out too soon, it is generally exposed to light for a short time in such a manner that the gelatine is rendered altogether insoluble where it is in contact with the glass. Another manner is to use chrome alum in the preparation. Again, a fine grain is given to its surface in a variety of ways, which facilitates the after process of printing. Taken in all, they may be considered as taking rank amongst the foremost of photo-mechanical processes.

We now come to perhaps the most beautiful of all these processes, not only in point of resembling perfectly the silver print, but also for the many important applications that spring from it. I refer to the Woodbury process, which differs essentially from all the rest, although starting from the same point. It was principally to carry out this process that I had the honor of being brought to this Colony, and I trust, with the continued assistance of the able and energetic gentleman at the head of the Government Printing Office, Thomas Richards, Esq., that it will, before long, speak for itself.

A glass plate is coated with a special collodion and dried; a compound of gelatine, sugar, glycerine, and Indian ink is then poured on and likewise dried; this is exposed behind the negative. When sufficiently impressed it is transferred to another plate, and all the portions of gelatine unaffected by light washed away. A very beautiful relief is the result; this is pressed into a sheet of lead by means of the hydraulic press, as much as four to five hundred tons of pressure being given to a relief of the dimensions of 12 to 10 inches. We have now a mould in metal; this has to be printed, or, more properly speaking, moulded; presses especially made for this purpose are arranged on a revolving table, one man being able to take charge of six presses. The mould is now placed on the bed of the press, a warm solution of gelatine and pigments is poured over it, a paper specially prepared placed on it, and the press shut down; the same operation is gone through until the six presses have been charged; when the gelatine is set, the presses are re-opened, and the paper lifted off the mould, bringing away with it the gelatine left in the hollows of the mould which forms the image; these are dried, fixed in alum, washed and re-dried, when they are ready for trimming

and mounting; they possess all the fine detail of the silver print and are perfectly permanent. Time would not allow me to enter into the many valuable and highly interesting ramifications of this process; suffice it to say that by its aid we can obtain the finest photo. engravings known, prepare metal blocks for type printers, make watermarks, transparencies for windows, &c., and magic lantern slides for educational purposes. Up to the present time no improvement of any importance has been made in this process, but we may reasonably hope that before very long such alterations will have taken place that will enable us to make moulds without the use of the hydraulic press.

Photo-chromo-lithography and photo-chromography come under the same head. In the first case a negative is made of the subject, say an oil painting; a photo-lithograph is then made of it, and the required number of transfers printed, that is for the number of tints required the same number of transfers are put upon separate stones. The chromist then commences his work, taking off from each stone such portions of the work as he does not require, and where required adding to the work; when all the stones are ready they are treated as ordinary chromo-lithographs. The advantages derived are great exactness in rendering the artist's outlines, less work for the chromist, less time occupied, and consequently less expense in the getting up.

Photo-chromography is practised in various ways, of which the following I consider to be the best:—Say 5,000 impressions are required of any subject, the copies are taken from an ordinary negative by means of the Woodbury process. A mosaic block is then made, composed of the colours required; the same number of prints are made from this block as from the negative, printed on an especially prepared paper. When both impressions are dry they are brought into contact and held together in their right places by a weak solution of gelatine. When again dry the paper holding the Woodbury print is removed, leaving the gelatine image firmly secured to the mosaic print, the two forming one picture, and have been produced by only two printings, which forms one of the most important features in the process.

I wish to remark that the observations I have made on these processes have only been such as to give the outlines of them, and are not intended as practical details, as it would be impossible in a paper of this description to enter into anything more than a general and brief review of them; but, independently of the place they occupy in photographic literature, I considered that it might be interesting to this Society to hear something of them from me, as I am aware that it was through the instrumentality of the Royal Society these processes were first introduced into the Colony; and I trust I may be allowed to

offer a tribute of respect and admiration to those gentlemen who were the first to introduce here these valuable and beautiful processes. It was a step in the right direction, for countries, like individuals, if they are to succeed, must have a healthy mind as well as a strong body, and no country can afford to slight such a powerful auxiliary to education, art, and science as photography and photo-mechanical printing.

In a paper I had the honor of reading before the Fine Art Section of this Society, I called attention to photography in its relation to, and as one of the Fine Arts. I will not therefore trouble you with a repetition of my remarks thereon, but I must ask your indulgence while I read an extract from a recent number of the *Art Journal* relative to photographic portraiture:

The *Art Journal* says :—

" Mr. Faulkner, of Baker-street, whose photographs generally, but of children more especially, have long been of unsurpassed excellence, is publishing a series of copies from nature of ' the little ones,' so exceedingly beautiful and perfect as works of art that high praise of them is a duty. At first sight, indeed, after minute inspection, so thoroughly does photography seem to be put aside that one receives them as transcripts after great painters, and is slow to believe that they have no other aid given to them beyond that they obtain from light, regulated by the mind of the photographer, who is as true an artist as any painter can be. We refer to those that are published, but a large number of his productions are the living pets of a household, and are not to be scanned by every eye. These treated as Mr. Faulkner has treated them are far more effective than any drawings can be; all the objections urged against photography vanish, the likeness is entire truth, and obtains all the value derivable from the most consummate art. Some portraits in his studio of fair and stately dames may be taken for copies from Gainsborough or Sir Joshua Reynolds. We may not say that the art can never go farther, but beyond question the art has never yet gone so far as Mr. Faulkner has carried it."

And now, in conclusion, let me say a few words relative to the position that photography occupies as a means of demonstration.

We find that it is used by almost all the European Governments, firstly in the form of photo-lithography for reducing and copying plans, where a great saving of time and capital is effected by its use; then since the introduction of photo-mechanical printing and permanent enlarged prints it is employed for illustrating the resources of these countries, for Government reports, for copying and vulgarizing the public collections of pictures of ancient and modern masters, rare objects from the museums, &c. Its use is still more wonderful in the Astronomical observations, and we are all more or less familiar with such names as Rutherford,

Draper, Vogel, Delarue and Janssen. Up to within very recently the photographs taken of the sun were very imperfect, but Janssen has brought them to perfection, and his wonderful photographs of the sun 18 inches in diameter show clearly markings of a twofold kind, some granular, and some elongated or willow-leaf shape. A magnified examination of these markings by Father Lamey, a French astronomer, has led to the remarkable discovery that the markings on the sun and moon much resemble one another. Father Lamey believes he can trace without difficulty, upon the solar pictures of Mr. Janssen, appearances that resemble the craters plainly shown in the Rutherfurd lunar photographs. The photographs here spoken of are enlargements of photographs taken of the moon, and are three feet in diameter. The blinding light of the sun had hitherto baffled the means at the disposal of of photo-astronomers, until the superior intellect and great perseverance of Janssen, who believed in the camera, took the matter up and arrived at the present state of progress. Rutherfurd's moon pictures, and Janssen's photographs of the sun stand out as two wonderful results in recent investigation, and prove beyond question the indispensability of a knowledge of photography for all who would in future follow this branch of science. I might also mention that it was Janssen who by means of photography discovered the photospheric network around the sun. Then again we have the barograph, thermograph, magnetograph, and a variety of other instruments used in the observatory for photographic observations, whose utility can be seen by consulting the published records of the establishments at Kew and Greenwich.

Medicine also finds valuable aid in the art of photography. Dr. Vogel cites a peculiar case of a lady, who as the phrase goes "takes well," but having been photographed, what was the surprise of all to find the face of the portrait covered with small black spots; naturally the photographer was blamed. Two days after, the lady was laid up with small-pox and died.

Yellow comes out black in the sun picture, so her face must have been covered with very faint yellow spots, before any eye could trace the least mark upon the skin. This is a case of the invisible, but there are many visible ways of utilizing photography. As in adjusting special photographic apparatus to the ophthalmoscope, laryngoscope, otoscope, &c., in which case medical men could study the various diseases at their leisure. Negatives like these enlarged for view during the lectures would be of great use to students.

A French gentleman (Monsieur Marcy) has also invented an apparatus by means of which the pulsations of the heart or pulse are photographed; in the same way the play of the muscles and the circulation of the blood may be described. To the general

looker-on this may seem of little service, but scientific men know better, and are daily adding to their store of knowledge that of photography.

One of the most remarkable things yet recorded is the photographing articulated speech. The possibility of this is asserted by Professor Blake, of Brown University. Dr. Klein, of Frankfort, and M. Konig, of Paris, have both shown figures or curves corresponding to certain noises; but this is the first time that a word or sentence uttered by the human voice has been recorded by the camera obscura. Professor Blake employed the mouthpiece of the telephone, and fixes to the vibrating plate a piece of steel wire, upon which a mirror is set. The mirror and vibrating plate being in perfect communication, all movements of the mouthpiece are imparted to the mirror. A bright ray or pencil of light is sent by a heliostat upon the mirror, which reflects it again, and it passes into the camera, where it is received upon a movable sensitive plate.

The mirror, as already stated, is attached to the vibrating plate in the mouthpiece of a telephone; consequently when any one speaks in the telephone the iron plate vibrates, and with it the mirror, the result being that the tiny spot of light inside the camera dances up and down upon the moving sensitive plate, and impresses upon the latter a series of curves; the rate at which the sensitive plate travels varies from sixteen to forty inches per second. These sounds are so marked and different that the study of them would no doubt teach us something more than we know at present of articulate speech.

Nor is Art behindhand in making use of photography—it has been the means of vulgarizing those beautiful studies of the great masters that for so long a time had been the property of the few. By its means we can all be possessors of copies of the works of such men as Albert Durer, Martin Schöen Leyden, &c., and how largely has it been applied to book illustration, and with what success we know! In the present age we require truthful illustrations—such illustrations that when we have seen them and then visited the places we have no trouble in recognizing them; such cannot be said of many hundreds of engravings used for book illustration, beautiful as works of art, but so changed by the artist's ideas to make up what he thinks is a picture, that truthfulness is left out of the question. To the ethnologist it is invaluable—all the peculiarities that are required in studies of this kind are at once depicted by photography; how interesting would be a public collection of photographs of the races that once peopled this country! 'Tis true there are several collections taken here and there for sale, but there exists no public and official collection, notwithstanding the great worth that would be attached to such a collection; not only for the purpose of adorning our native

museums and libraries, but how gratefully would some enlargements of these races be received by the scientific bodies at Home and on the Continent. Take again the case of the Fiji Islands: how valuable a history of this new addition to our country may be made by a carefully regulated tour with the camera. Manners and customs, races and habitations, everything of real interest might be faithfully made to the general benefit of all—interesting to the general public who like to know all about such things; interesting to keep in the records of the country; interesting to science and art, in short to all; and since knowledge is power, and we possess all the necessary requirements for that knowledge, the fault is our own if we do not avail ourselves of these privileges. One more remark, I would mention micro-photography; a world of wonders has been brought into view by this branch of the art; wonders never dreamt of have become familiar facts; so astonishing is this branch of photography that if required all the books in the British Museum library might be reduced and packed in a chest of drawers. I might go on enumerating for a long time the many applications of photography, but I must desist; suffice it to say, that all who are engaged in the study of art or science find in photography a valuable friend;—to the manufacturer it has became a necessity and its service in daily life as a portraitist is simply unbounded. I cannot do better than finish this paper in the words of a writer in *All the Year Round*, "If you do not understand photography, learn it at once."

PROCEEDINGS.

PROCEEDINGS

OF THE

ROYAL SOCIETY OF NEW SOUTH WALES.

WEDNESDAY, 1 MAY, 1878.

ANNUAL General Meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

Mr. Christopher Rolleston, V.P., in the chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society :—

Samuel T. Knaggs, M.D., Newcastle.
Frederick Griffiths, Macquarie-street.

The certificates of eight new candidates were read.

One hundred and sixty-one donations were laid upon the table.

The Annual Report of the Council was then read :—

"The Council, in bringing before the Society their annual report, refer with satisfaction to the continued progress in the number of its members, and to the growing interest taken in the work of the Society, as evinced by the enlarged attendance of members at the monthly general meetings.

"At the beginning of last session of 1877 there were 298 members on the rolls, sixty-two new members were elected during the session closed in December last, while three members died and ten resigned, leaving at the opening of the present session of 1878 347 members, besides fourteen honorary members.

"This steady increase in the number of members warrants the hope on the part of the Council that the active interest taken in the scientific work which this Society is intended to foster throughout the Colony will extend more and more. Hitherto the number of active members who have taken part in the bringing of matters of scientific interest before the Society, either at its general monthly meetings, or at the monthly sectional meetings, has been comparatively small, and the acquisition of a few more 'working bees' would be welcomed by every one who has the welfare of the Society and of the Colony at large at heart.

"In establishing nine (9) different Sections during the session of 1876 it was intended to give every member a favourable opportunity for bringing any matter of scientific interest before the Society, even without requiring to dress those observations in the garb of a more or less elaborate paper, such as would be laid before the monthly general meeting.

"It is hoped these Sections will be more fully made use of during the present session. The preliminary meetings for the election of officers for each section, and the fixing of the days of meeting, were held much earlier this year than before, viz., during the early part of last month. This will enable each Section to begin their regular monthly meetings this month, and thus to secure during the current year seven monthly sectional meetings, besides eight monthly general meetings.

"The financial position of the Society, as shown by the balance-sheet of the Hon. Treasurer, laid before the Society this evening, is in every way satisfactory. To the general receipts from subscriptions and entrance fees is, for the first time, to be added the sum of £200, which Parliament had liberally granted under the condition of a double amount being received from private sources.

"This addition to our ordinary income enabled the Council to expend a larger sum on books and periodicals and other necessary requirements than they would otherwise have been enabled to do. The Government and Parliament has thus recognized the position of the Society, and it must be the desire of each of its members to make the Society increasingly useful.

"During last year the appeal to the Government for assistance towards providing a suitable building for the Society has been answered, Parliament having granted the sum of £500 conditionally that the sum of £1,000 be subscribed for the same purpose by the public.

"A circular was, therefore, addressed in September last to every member of the Society, in response to which up to April last the sum of £475 2s. had been promised towards such a building fund, leaving still about £525 to be provided for. Our Honorary Treasurer, the Rev. W. Scott, thereupon laid the matter before Mr. Thomas Walker, of Yaralla, a gentleman always ready to support most liberally anything which he considers to benefit the Colony, in a letter addressed to him on the 11th of April last. To this letter Mr. Thomas Walker replied the same day, and in the most liberal manner subscribed £500 towards this fund, which, but for this generous help, would probably have collapsed. There is now but about £25 needed to complete the subscription of £1,000, which, when collected, will enable the Council to apply to Government for the payment of the aforesaid Parliamentary grant of £500.

"The Council, while happy to be able to report to the members the present position of the building fund, think it but right to point out that but about seventy members, out of 347 on the rolls of the Society, have hitherto contributed to this building fund; and though we are now, by Mr. Walker's most liberal assistance, placed in a position presently to claim the Government grant, this fact ought all the more to induce those members who have not yet subscribed to come forward without delay and liberally assist in a work not only of benefit to ourselves, but in a wider sense to the Colony at large. It must be self-evident that £1,500 will be far from sufficient to accomplish the object in view except by borrowing on mortgage, therefore every assistance must be valuable, and where about 350 members unite, even small individual subscriptions become in the aggregate most useful to the end in view.

"The Council has, within the past few days, taken active steps to secure the building which hitherto has been leased by the Academy of Arts, and partly sublet by the latter to the Royal Society; the Council considering this building, with few alterations, the most eligible for the purposes of the Society. The purchase of the said building and premises for the sum of £3,525, has been agreed upon, subject to a favourable report by our solicitor as to title.

"Mr. Henry Heron, solicitor, and a member of this Society, has most kindly undertaken to prepare a charter for the Society, which, when passed through Parliament, will put the Society on a proper legal footing.

"During the last year the Hon. Secretaries have forwarded the Journal of the Society for 1876, and other publications entrusted to them for distribution abroad, to no less than 228 places, Great Britain and the Colonies, the Continent and America, comprising in all 1,066 publications. The Society has thus been the means of communication with the principal centres of learning in the world, and a vast amount of benefit is already derived from the liberal donations of publications received by the Society in return. These donations have amounted since May, 1877, to the present day, to no less than 880 publications, among which are many most valuable books. Besides these donations, the library has been enriched during last year by the purchase of several valuable scientific works, and a regular supply of thirty-four periodicals in English, French, and German. Thus, in time a very valuable scientific library will be secured.

"The Journal and Proceedings of the Society for 1877 are in course of distribution to the members. The Council acknowledge here, with thanks, the expedition on the part of the Government Printing Department, which thus enabled the members to receive last year's Journal at the beginning of the new session."

Honorary Member.

In accordance with a recommendation from the Council, Thomas Walker, Esq., of Yaralla, Concord, was duly elected honorary member of the Society.

The following Financial Statement for the year ending 30 April, 1878, was presented by the Rev. W. Scott, M.A., Honorary Treasurer :—

Receipts.	£	s.	d.
To balance in the Union Bank, 30th April, 1877	123	3	2
,, Subsciptions and entrance fees	433	13	0
,, Government Grant	200	0	0
,, Professor Liversidge (for engravings)	9	5	8
	£766	1	10

Disbursments.	£	s.	d.
By rent of rooms from 1st May, 1877, to 30th April, 1878	50	0	0
,, Office-keeper (Mrs. Casey), to 30th April, 1878	10	10	0
,, Hire of Masonic Hall for conversazione	9	0	0
,, Refreshments do. do.	25	0	0
,, Sundry expenses do. do.	22	7	2
,, Refreshments for monthly meetings	14	0	0
,, Furniture and effects	61	14	6
,, Books	89	19	9
,, Engravings	74	15	0
,, Printing account	77	5	9
,, Stationery do.	30	12	1
,, Petty cash and postage account	47	0	0
,, Book-binding	40	19	0
,, Advertisements	21	3	4
,, Gas account	10	0	0
,, Reporter	6	6	0
,, Bank commission on draft cheques	2	8	0
,, H. W. Ingram (collector) commission	1	7	3
,, Packing cases, insurance, &c.	11	3	6
,, Assistant Secretary (Mr. Catlett) to 30th April, 1877	23	6	8
,, Mr. Casey, distributing books	5	18	9
,, Assistant Secretary, twelve months salary to 30th April, 1878	60	0	0
,, ,, extra services	7	11	0
,, Balance in the Union Bank on the 30th April, 1878	63	14	1
	£766	1	10

Assets.	£	s.	d.
To balance in the Union Bank	63	14	1
,, Subscriptions and entrance fees due	19	19	0
,, Furniture, Books, Pictures, &c., as insured	400	0	0
	£483	13	1

Liabilities.	£	s.	d.
By periodicals ordered	47	0	1
,, Balance of assets over liabilities	436	13	0
	£483	13	1

The statement was adopted

The Honorary Treasurer reported that including the £500 from Mr. Thomas Walker, the subscriptions promised towards the Building Fund up to 30 April, 1878, amounted to £976 3s., as per the following list:

	£	s.	d.
Abbott, Thomas Kingsmill	3	3	0
Bartels, W. C. W.	5	0	0
Belfield, Algernon H.	3	3	0
Bensusan, S. L.	2	2	0
Bennett, George F.	1	0	0
Bladen, Thomas	2	2	0
Bolding, H. J.	5	0	0
Bowen, George M. C.	3	3	0
Brazier, John, C.M.Z.S.	2	2	0
Brodribb, W. A., F.R.G.S.	10	10	0
Brown, Thomas	5	0	0
Burnell, Arthur	2	2	0
Campbell, Allan, L.R.C.P.	5	0	0
Campbell, The Hon. Alexander, M.L.A.	20	0	0
Clarke, Rev. W. B., M.A., F.R.S., F.R.G.S., &c.	5	5	0
Croudace, Thomas	3	0	0
De Salis, The Hon. Leopold Fane, M.L.C.	10	0	0
De Salis, L. W., jun.	10	0	0
Dixon, W. A., F.C.S.	1	1	0
Docker, Ernest, M.A.	3	3	0
Fairfax, James R.	20	0	0
Fairfax, Edward	10	10	0
Flavelle, John	5	0	0
Flavelle, Brothers, and Roberts	5	0	0
Frazer, The Hon. John, M.L.C.	20	0	0
Gilliatz, Henry A.	1	1	0
Graham, The Hon. W., M.L.C.	5	0	0
Griffiths, F. C.	5	0	0
Hay, The Hon. John, M.A., M.L.C.	20	0	0
Holt, The Hon. Thomas, M.L.C.	10	0	0
Henry, James	3	3	0
Horton, Rev. Thomas	2	0	0
Hume, J. K.	3	3	
Hume, F.	5	5	
Jones, P. Sydney, M.D., F.R.C.S.	10	10	0
Josephson, J. F., F.G.S., District Court Judge	20	0	0
Keele, Thomas W,	3	3	0
Knox, Edward S.	20	0	0
Leibius, Adolph, Ph.D.	5	5	0
Lenehan, Henry A.	2	2	0
Liversidge, Archibald, F.C.S., F.G.S., &c.	10	0	0

	£	s.	d.
MacDonnell, William	5	0	0
Mackenzie, John, F.G.S.	5	0	0
Manning, Frederick N., M.D.	5	5	0
Martin, Rev. George	2	2	0
Merriman, James	5	5	0
Moore, Charles, F.L.S.	5	0	0
Morehead, R. A. A.	10	0	0
Mullens, Josiah	10	0	0
Murray, W. G.	5	0	0
Olley, Rev. Jacob	1	1	0
O'Reilly, W. W. J., M.D.	1	1	0
Paterson, Hugh	2	0	0
Rolleston, Christopher	10	0	0
Russell, Henry C., B.A., F.R.A.S., &c.	10	0	0
Scott, Rev. William, M.A.	5	0	0
Sharp, James B., J.P.	5	5	0
Smith, The Hon. J., C.M.G., M.D., LL.D., &c.	5	0	0
Smith, Robert, B.A.	10	10	0
Suttor, William Henry, J.P.	7	10	0
Taylor, William George, F.R.C.S.	1	1	0
Tebbutt, John, F.R.A.S.	10	0	0
Thomas, H. A.	3	0	0
Toohey, J. T.	10	10	0
Trouton, F. H.	3	3	0
Tucker, G. A.	10	10	0
Voss, Houlton H.	10	10	0
Ward, J. W.	5	0	0
Waterhouse, J., M.A.	2	2	0
Watt, A. J.	5	0	0
Walker, Thomas	500	0	0
Webster, A. S.	10	0	0
Woolrych, F. B. W.	3	3	0
Wright, H. G. A., M.R.C.S.	5	5	0
	£976	3	0

still leaving the sum of £23 17s. to be subscribed before he could claim the Government grant of £500, but he trusted this amount would be made up by those present before leaving the room.

He was glad to inform them that the Council were in treaty for the purchase of the building they were now in, and that there was every probability of their being successful; but he begged to draw attention to the fact that nearly £500 had been subscribed by 73 members out of about 350 on the rolls of the Society, and that as considerable funds would be required towards the purchase

of the building (after obtaining the Government grant), he hoped those members who had not hitherto promised anything would come forward and give them a helping hand.

A ballot was then taken, and the following gentlemen were duly elected officers and members of Council for the current year :—

PRESIDENT

(ex officio):

HIS EXCELLENCY SIR HERCULES ROBINSON, G.C.M.G., &c., &c., &c.

VICE-PRESIDENTS:

REV. W. B. CLARKE, M.A., F.R.S., F.G.S.,
HON. J. SMITH, C.M.G., M.D.

HONORARY TREASURER:

H. C. RUSSELL, B.A., F.R.A.S., F.M.S.

HONORARY SECRETARIES:

PROFESSOR LIVERSIDGE. | DR. ADOLPH LEIBIUS.

COUNCIL:

FITZGERALD, R. D., F.L.S.	MOORE, CHARLES, F.L.S.
GURNEY, PROFESSOR, M.A.	ROLLESTON, CHRISTOPHER.
JONES, P. SYDNEY, M.D.	WRIGHT, H. G. A., M.R.C.S., E.

Dr. LEIBIUS stated that arrangements had been made for the various Sections to hold meetings during the ensuing year on the following dates :—

	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
General Monthly, Wednesday, 8 p.m.	1	5	3	7	4	2	6	4
Council, Wednesday, 4·15 p.m.........	29	26	31	28	25	30	27	11

SECTIONS.

At 8 o'clock p.m., except Sect. D, which meets at 4 p.m.

	May.	June.	July	Aug.	Sept.	Oct.	Nov.
A—Astronomy, &c. Friday	3	7	5	2	6	4	1
B,C—Chemistry and Geology, Wednesday	22	19	17	21	18	16	20
D—Nat. Hist. & Botany, Monday, 4 p.m.	6	3	1	5	2	7	4
E—Microscopy, Monday	13	10	8	12	9	14	11
F.—Geography .... } Lapsed.							
G—Literature and Fine Arts } Lapsed.							
H—Medical, Friday	10	4	12	9	13	11	8
I—Sanitary, Monday	20	17	15	19	16	21	18

NOTE.—The Literature and Fine Art Section was resuscitated 26 July, 1878.

and announced the following names of the Committee-men of the different Sections of the Society, viz. :—

Section A—*Astronomy.*—Chairman: H. C. Russell, B.A., F.R.A.S. Secretary: G. D. Hirst. Committee: H. G. A. Wright, M.R.C.S.; W. J. MacDonnell, F.R.A.S.; Rev. G. Martin, I. U. C. Colyer.

Sections B, C—*Chemistry and Geology.*—Chairman: Dr. Leibius. Secretary: W. Dixon, F.C.S. Committee: Messss. Sleep, M'Cutcheon, Bensusan, Gipps.

Section D—*Natural History and Botany.*—Chairman: R. D. Fitzgerald, F.L.S. Secretary: A. J. Stopps. Keeper of Herbarium: W. D. Armstrong. Committee: Messrs. Daintrey and James Norton.

Section E—*Microscopy.*—Chairman: Rev. George Martin. Secretary: P. Pedley. Committee: G. D. Hirst, W. MacDonnell, W. Morris, L.F.P. and S. Glas.; H. G. A. Wright, M.R.C.S.

Section H—*Medical.*—Chairman: H. G. A. Wright, M.R.C.S. Secretaries: Drs. Sydney Jones and MacLaurin. Committee: A. Roberts, M.R.C.S.; Drs. Schuette & O'Reilly, and M. S. Clune, M.A., Lic. K.Q., Coll. Phy.

Section I—*Sanitary.*—Chairman: Alfred Roberts, M.R.C.S. Secretary: Harrie Wood. Committee: Hon. J. Smith, C.M.G.; H. G. A. Wright, M.R.C.S.; W. J. G. Bedford, M.R.C.S.; and Dr. Belgrave.

Mr. Christopher Rolleston (Vice-President) then read his address, and referred to some of the more important scientific discoveries and investigations of the past year.

WEDNESDAY, 15 MAY, 1878.

The annual Conversazione given by the Society was held in the Masonic Hall, York-street, at 8 p.m. on the evening of May 15, 1878.

The attendance was larger than on any previous year; the members on this, as on former occasions, were permitted to introduce the ladies of their families.

The Vice-Presidents and Council received the visitors at the eastern entrance to the large hall, which together with the hall, were appropriately decorated by Mr. C. Moore, F.L.S., Director of the Botanic Gardens, who also exhibited a fine collection of rare plants.

The proceedings commenced by the Hon. J. Smith, C.M.G., M.A.D., V.P., delivering an introductory address which referred briefly to the various objects in the hall possessing more than a passing interest. Amongst the more prominent was the large collection of telegraphic apparatus exhibited by Major Cracknell,

the Superintendent of the Telegraph Department, and which was under the supervision of Mr. P. B. Walker, the Assistant Superintendent, assisted by Messrs. Dalgarno, Wilson, and Maguire, all of whom were present to explain the various technicalities. Amongst the numerous instruments on view was Fuller's mercury-bichromate battery connected with automatic and quadruplex instruments; also Major Cracknell's torpedo-exploding shutter apparatus, together with a dynamo-electric apparatus intended for torpedo purposes in Sydney Harbour.

Mr. Dalgarno exhibited a private collection of magnetic and electric instruments, including an electric battery for curative purposes.

Amongst the astronomical instruments exhibited by the Government Astronomer was a new barrel chronograph for registering star transits, the pen of which by the action of electro-magnets had two motions.

Mr. Russell also had on view a meteorograph instrument designed by himself and made at the Observatory, for registering on a sheet of paper 20 inches long by 8 inches wide one day's record of thermometer, barometer, direction and force of wind and rain.

There was a fine collection of microscopes, and amongst the objects shown were the following:—The circulation of the sap of the *Nitella translucens*—a species of water plant, samples of sediments of the water used in Sydney for domestic purposes; the cornea of a beetle's eye, which could be seen to be composed of various smaller lenses each producing a separate image; and the orange-perforating moth belong to the genus Ophideres.

A model printing press at work was exhibited by the Government Printer; and a large number of interesting objects, including geological specimens, rare old books and engravings, photographs, autotypes, etchings, &c., the necessary references to which were made in the printed Catalogue.

The Conversazione Committee consisted of the following gentlemen:—

Rev. W. Scott, M.A.
Dr. Leibius.
H. C. Russell, B.A., F.R.A.S.
C. Moore, F.L.S.
G. D. Hirst.

WEDNESDAY, 5 JUNE, 1878.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

HON. J. SMITH, C.M.G., M.D., V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary Members of the Society, viz. :—

Robert Hunt, F.G.S., Royal Mint, Sydney.
Richard Thomas Hall, Seaton House, Crown-street, Surry Hills.
Francis Lindsay Barker, 130, Pitt-street.
Francis John Fuller, St. Leonards, North Shore.
Rev. Samuel Wilkinson, Islington Cottage, Munni-street, Newtown.
James Thomas Wilshire, C.P.S., Scone.
George Moses Alexander, 48, Margaret-street.
J. H. Skinner, St. Paul's College, Darlington.

The certificates of nineteen new candidates were read.

One hundred and ninety-four donations were laid upon the table.

The Hon. TREASURER drew attention to the unsatisfactory condition of the Building Fund, and stated that until the £1,000 promised had been raised, the grant of £500 voted could not be paid by the Government. The advisability of securing subscriptions as speedily as possible was urged on the Members by the Chairman, who pointed out that the purchase of the proposed building would be even profitable as a commercial speculation.

The Rev. J. E. TENISON-WOODS, F.L.S., F.G.S., then read a paper on "Timber-producing Forests of Tasmania."

Mr. JOHN TEBBUTT, F.R.A.S., then read a paper on "A Proposed Correction to the Assumed Longitude of the Sydney Observatory."

WEDNESDAY, 3 JULY, 1878.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's rooms, Elizabeth-street, the Hon. J. SMITH, C.M.G., M.D., V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The CHAIRMAN delivered the following address :—" It is impossible to go on with the business of this meeting without referring to the great loss the Society has recently sustained in the removal by death of our senior Vice-President, the Rev. Mr. Clarke. A detailed notice of his life and labours will have to be given at the next annual meeting, but we cannot wait till then without giving some expression to our feelings. Mr. Clarke was one of the steadiest friends of our Society, and always one of its most efficient supporters. He attended regularly the general meetings and the meetings of the Council whenever it was in his power, and we were indebted to him for many valuable papers and addresses. It is pleasant to think that in his last days he suffered little pain,

and that his faculties remained unclouded to the end. A fortnight before his death he had completed a new edition (the 4th) of the 'Sedimentary Formations of New South Wales,' a copy of which is on the table, and I understand that he had also finished the preparation of a geological map of the Colony. On the last day of his life he busied himself arranging fossils, and in writing a letter to Professor de Koninck, of Liége, who had examined and named many of his specimens. This letter, through the kindness of his son, Mr. M. Clarke, I have been able to bring with me, and I will read portions of it for the sake of the interesting particulars relating to his last illness:—'Branthwaite, 15th June, 1878. My dear Professor de Koninck,—You have doubtless expected to hear from me before this, but I have been sorely hindered in writing. I have before told you of my general weakness in health since the first days of August last; but I did not anticipate such a culmination as I have since experienced, and from which I am only now slowly recovering. I went with the Chief Engineer of Railways in the beginning of August to the Liverpool Range and Plains, and visited some of my old camps in 1851-2, returning the better for the journey to and fro. This amendment was followed by paralysis of my left side and limbs, and this is the second letter I have attempted since the date of the attack, which was the 6th of March. I was seated in my arm-chair in this my study, when, trying to rise to get down a book, I found myself a prisoner bound hand and foot, and after two hours struggling to lift myself I gave it up, and began to call for help, with cries of fire, murder, thieves, &c., which I soon discovered was useless, as I found my speech anything but intelligible. Knocking on the floor with my right foot brought my son from the garden, and I was soon attended by my usual medico, Dr. Ward, and by a young friend of his, Dr. Kyngdon, who with my own son carried me upstairs to bed, where, with some exceptions, I have since chiefly rested. Dr. Kyngdon said to me, "Put out your tongue," and this done, he observed, "Your tongue is half paralyzed.' This was intimation to me of my condition. I am now, however, so far recovered as to be able to walk upstairs, step by step, holding the banister; but I can only come down sideways, crab-like, with both feet on a step, the left sliding over the one above; and I have once, by aid of two assistants, managed to visit a friend across the road. Dr. W. said to my wife * * that he did not think I should recover, and now he has expressed to me his astonishment that I am so far towards health. I must apologize to you for this scrawl, but I did not like to wait till I could write better * * I had just completed the MSS. of a fourth edition of my 'Remarks' when the stroke came, and by the help of my son I have got it through the press, but the copies have not yet left the printing office. * * * * * * I had a

somewhat similar attack in 1856, which occurred on Easter Sunday in church, and I had a hard struggle to get through my ministerial duties. But God is ever merciful, and I am not despairing of his loving-kindness towards me now. All my friends will have it that I have suffered from over-work about the book. Perhaps they are right, for I had to make a good deal of research to complete it. * * * * * My new edition brings us all to 1878, and gives lists of fossils, from various authorities, with fresh sections, and a small map. I hope you have in some degree recovered from the effects of your severe sorrow, and, with the warmest regard, sympathy and gratitude, I remain, my dear friend, Yours, very sincere.—W. B. CLARKE.—P.S.— * * * * Lastly, give me absolution for this letter, which is a shameful production; but I cannot do more.' These concluding words had a deeper significance than the writer was aware of. About the middle of the same night he was heard making some noise in his room. His son went to him and found him standing on the floor complaining of pain across his chest. He was assisted into bed, and the doctor sent for, but within ten minutes it was all over. On June 18 the Council and many members of the Royal Society paid the last tribute of respect and affection to their late Vice-President by following him to the grave. And now we shall long miss the well-known face at these meetings, and the cheering voice, ever ready with a kindly greeting for his fellow-members and friends."

MR. H. C. RUSSELL, B.A., F.R.A.S., moved the following resollution :—"That the members of the Royal Society of New South Wales desire to express their grief for the loss which the Society has sustained by the death of their late Vice-President the Rev. W. B. Clarke, F.R.S., and at the same time express their sympathy with Mrs. Clarke and the members of his family. That a copy of this resolution be sent to Mrs. Clarke."

The resolution was seconded and unanimously agreed to.

Mr. J. R. FAIRFAX moved the following resolutions :—"1. That, in the opinion of this Meeting, the distinguished services rendered by the late Rev. W. B. Clarke, not only to these Colonies, but in the cause of science, call for some special recognition throughout the Australian group. 2. That an opportunity for the public generally to give expression of their appreciation of the character and services of the late Rev. W. B. Clarke as a learned colonist, a faithful minister of religion, and an eminent scientific man, may be most appropriately afforded through the medium of this Society, of which he was for so many years senior Vice-President. 3. That the Council of the Royal Society be requested to take the necessary steps to bring before the inhabitants of the Australian Colonies the subject of the foregoing resolutions, with

a view to provide a suitable memorial of him whose decease we lament, and whose services to science, as well as in connection with the development of our mineral resources, command our grateful acknowledgment."

The Resolutions were duly carried.

Professor Gurney, M.A., moved "That the following gentlemen be appointed a Committee to co-operate with the Council in carrying out the objects of these resolutions, viz. :—

Messrs. J. R. Fairfax, J. Kinloch, R.A. A. Morehead, W. G. Murray, A. S. Webster, and E. L. Montefiore.

The Resolution was agreed to.

The following gentlemen were duly elected ordinary members of the Society :—

Edwin Chisholm, M.D., M.R.C.S., L.S.A., &c., 161, Macquarie-street.
Vincent W. Giblin, Australian Joint Stock Bank, Sydney.
E. W. L. Herborn, Victoria-street, Darlinghurst.
Alfred P. Backhouse, M.A., Ithaca, Elizabeth Bay.
Numa Joubert, Noumea.
Joseph Brooks, F.R.G.S., Hope Bank, Nelson-street, Woollahra.
James Markey, L.R.C.S., Irel. L.R.C. Phys. Edin., Regent-street.
Ludovico Hart, Government Printing Office.
William C. Goddard, The Exchange, New Pitt-street.
Edward Wm. Welch, St. Olive's, Bondi.
Edwd. H. Fry, 4 Verena Terrace, Walker-street.
E. E. Smith, Struth's Wharf, King-street.
James Balfour, Union Club.
Lamont G. N. Young, Assoc. R. S., Mines, F.G.S., Dept. of Mines.
Alexander Paterson, M.D., M.A., 117, Castlereagh-street.
Hugh George, *Sydney Morning Herald* Office.
John Rendell Street, Birtley, Elizabeth Bay Road.
F. Poolman, Colonial Sugar Refining Co., Bridge-street.
Hugh Paterson, junr., 247, Macquarie-street.

The certificates of nine new candidates were read.

The Chairman announced that the Council had in contemplation the election Mr. Charles Moore, F.L.S., as one of the Vice-Presidents, in the place of the Rev. Mr. Clarke, for the remainder of the year. One hundred and thirty-six donations received since the last meeting were laid upon the table.

Mr. W. A. Dixon, F.C.S., F.I.C., read a paper on "Metallurgy of Nickel and Cobalt."

Mr. H. C. Russell, B.A., F.R.A.S., then read a paper by Capt. Marshall Smith, of the ship "T. L. Hall," on "The Meteorology of the Coast of New South Wales, and the desirability of issuing cautionary storm warnings by telegrams to the various ports, from the Observatory."

WEDNESDAY, 7 AUGUST, 1878.

Ordinary monthly meeting, of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz. :—

T. H. Potts, Victoria-street, Ashfield.
Thomas Browne, J.P., Darlinghurst Road.
Reginald James Black, Bank of New South Wales, Sydney.
F. B. Kingdon (care of Lieut. Taunton), Victoria Barracks.
Rev. D. Placid Quirk, M.A. (Sydney University), Post Office, Cook's River.
Rev. E. G. Hodgson, St. Paul's College, University.
Eugene Herborn, 318, Victoria-street, Darlinghurst.
George Butterfield, Buckland-street, Newtown.
Hamilton Lambert Low, 139, Phillip-street.

The certificates of twelve new candidates were read.

The Chairman said that a copy of the resolution of condolence with Mrs. Clarke, passed at the last evening, in reference to the death of the late Rev. Mr. Clarke, having been forwarded to Mrs. Clarke, a letter had been received in reply from Mr. Clarke's son.

The Secretary read the letter as follows :—

Branthwaite, St. Leonards,
8 July, 1878.

Dear Dr. Leibius,

I have been requested by my mother to convey to you her sincere thanks for your kind sympathy for her in her deep sorrow; also her grateful acknowledgment of the gratifying mention made of my much-lamented father at the late meeting of the Royal Society. Allow me also to express my deep sense of the honor bestowed on his memory, and to wish for the Royal Society all the success which he so earnestly desired.

I am, my dear Dr. Leibius,
Yours faithfully,
M. W. S. CLARKE.

A. Leibius, Esq.,
Secretary Royal Society, N.S.W.

The Chairman said that the general committee appointed to carry out the resolutions respecting the Rev. W. B. Clarke had had several meetings and a good deal of discussion. Various plans had been suggested, and it was agreed that the memorial should take the form of an annual course of lectures on geology, free to the public, to be delivered under the auspices of the Royal Society. These lectures would be known as the Clarke lectures on geology,

or some such term as that. And it was also proposed that a gold medal should be given from time to time as a reward of meritorious contributions to geological science. It was intended that they should follow the example of the Murchison medal given by the Geological Society of Great Britain. There might be some difficulty in determining precisely how it should be given, but it was not thought necessary at this stage to go into details. The fact was that the exact character of the memorial must be determined to a large extent by the amount of the contributions; but it was thought that they could not ask for contributions from the public without a definite statement in the first instance of what was proposed. There was the proposition of the joint committee—an annual course of lectures and a gold medal. The joint committee, he thought, were invested with full powers to deal with this matter, but he thought it was the feeling of the committee that it would be well to have the sanction of the meeting of members so as to strengthen them in their intentions and enable them to go to the public with confidence to call for subscriptions to carry out these ends. They knew that there were differences of opinion about the form of a memorial, and it was not professed that these things were the very best possible, but they seemed to be things that were most easily within their power. Various suggestions were made, attended by considerable difficulties in their carrying out; and the committee saw its way more clearly to carry out the memorial in these two forms than in any other. It was also thought that taking these forms it would attract more general sympathy. If plenty of money were subscribed—enough to do these things and something over—then they might have some permanent memorial in the shape of a bust to be put in some public institution. But the committee though that at present there was no use to go any further until they saw what response was likely to be made to the appeal to the public. He did not know that it was necessary to ask a formal sanction to these proposals by a vote of this meeting. He thought the powers conferred on the committee pretty large, but he believed the committee would like to have some kind of sanction from the meeting, whatever they might choose to give. It had been suggested that unless some actual disapproval was stated they would take silence as consent. (Hear, hear.)

Mr. J. Henry should like to express his disapproval of the proposals. With all due deference for the views of the committee, he still maintained respectfully that a scholarship in the University for geology and other subjects connected therewith would perpetuate the memory of the late Mr. Clarke in a far more substantial manner than monumental brass or marble. He also submitted that a scholarship would be of far more benefit to the

rising young men of Australia than the forms suggested. The course of lectures would attract very few persons, and would hardly appeal to any feeling of sympathy. He gathered from what he had heard that this medal was to be given to young persons unconnected with the University; but he thought the time was far distant when they would have a class of young men who would be able to pursue their studies apart from some help from the University. He thought it was a great mistake to establish these lectures unless you gave young men the foundation of a hope of reward to stimulate their love for science. While these were his views, he was willing to assist in whatever was generally decided upon.

The CHAIRMAN said that the idea of a scholarship was discussed by the committee, and he must say that his sympathy rather went in that way; but there were certain difficulties in the carrying out of the idea, that were thought sufficient by the committee to cause it to be set aside.

Mr. CHARLES MOORE would only mention one objection to Mr. Henry's proposal; and that was that the University lectures were only open to a certain portion of the public, whereas lectures under the Royal Society would be open to the public at large.

The subject then dropped.

The CHAIRMAN announced that, in accordance with the rules, the Council had at their last meeting elected Mr. Charles Moore, F.L.S., one of the Vice-Presidents of the Society, to fill the vacancy caused by the death of the late Rev. W. B. Clarke, and that Mr. E. L. Montefiore had been elected a member of the Council in the place of Mr. Charles Moore, in each case for the remainder of the year.

Seventy donations were laid upon the table.

The CHAIRMAN intimated that the Society had just received notice of the death of Professor Henry, Secretary and Director of the Smithsonian Institute, who had been one of the Society's most valuable correspondents, and had sent them a great many contributions every year.

The Hon. TREASURER gave notice of his intention to move at the next General General Meeting that an addition be made to By-law XV.

Mr. H. C. RUSSELL, B.A., F.R.A.S., then read a paper on "Storms on the Coast of New South Wales,"

A microphone constructed by the Rev. Frank Firth was exhibited by Mr. William MacDonnell, who read a short paper by the Rev. F. Firth upon it; several interesting experiments were then successfully made.

WEDNESDAY, 4 SEPTEMBER, 1878.

Ordinary Monthly Meeting of the Royal Society of New South Wales held at the Society's Rooms, Elizabeth-street.

CHARLES MOORE, F.L.S., V.P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz.:—

Rev. Canon Moreton, St. Peter's Parsonage, Woolloomooloo.
Octavius L. Montefiore, Gresham-street.
S. De Lissa, 3 Barrack-street.
Rev. Peter Macpherson, M.A., Bank-street, East Maitland.
Fred. H. Kyngdon, M.D., L.S.A., M.R.C.S., C.M., North Shore.
G. W. A. Bayley, Miller's Point.
George H. Reid, Secretary to Attorney-General.
Henry Wise, Savings' Bank, Barrack-street.
Rev. Edwin H. Wright, Dubbo.
George Colquhoun, care of Messrs. Want & Johnson, Solicitors.
Robert J. Marklove, 52 Pitt-street.
William Roberts, Penrith.

The certificates of thirteen new candidates were read.

Mr. A. S. WEBSTER, Hon. Treasurer to the Clarke Memorial Fund, announced that the subscription list was lying upon the table, and that the Secretary and Treasurer would be glad to receive the signatures of members present.

The CHAIRMAN stated that the number of subscriptions to date was forty, and the amount subscribed and promised, £136; he regretted the amount was not larger.

The HON. SECRETARY (Dr. Leibius) announced the receipt of a microscope ordered by the Society, and which had been selected by Professor Liversidge; he also stated that in the matter of the purchase Mr. Swift had treated the Society very liberally.

Eighty-one donations were laid upon the table.

On the motion of Mr. H. C. RUSSELL, seconded by Dr. LEIBIUS, and duly carried, the following addition was made to By-law XV, viz.:—

"And any member who shall be two years in arrear with his subscription shall be considered to have resigned."

The Rev. J. E. TENISON-WOODS, F.L.S., F.G.S., then read the two following papers:—

1. "On Molluscan Fauna of Tasmania."
2. "On some new Australian Miocene Corals."

Mr. THOMAS BLADEN exhibited a phonograph made by him, and after reading a short paper describing the instruments, a series of experiments were tried, which were very successful, and caused much amusement.

After concluding his paper, Mr. Bladen said he would commence the experiments by asking his son to say something in the tube.

Mr. BLADEN, junr., speaking in the tube in a loud, clear tone of voice, said: "Gentlemen, I am a phonograph, some people think I can't talk, but I can talk a little. How do you like me? How do you do? Good night."

These words were faithfully reproduced by the phonograph, and distinctly heard by all the members present, who warmly applauded the result. At the request of a member, Mr. Bladen made the instrument repeat the words.

The next experiment was with the words "Advance Australia! God save the Queen."

These words were also successfully repeated by the instrument.

Mr. BLADEN, senr., in answer to an inquiry, said the instrument was capable of repeating about 250 words. Mr. Eddison, the inventor, was making an instrument that would record 500 words.

A member asked if it would reproduce musical sounds.

Mr. BLADEN, senr., said he had tried it with the flute and the cornet, but it did not give the proper tone; it gave the time correctly, and all the notes, but not the same tones.

Mr. BLADEN, junr., next delivered the following words in the tube: "Gentlemen, I beg to propose a vote of thanks to Mr. Eddison, for his very interesting invention.—Coo-ee!"

The phonograph repeated the words with unvarying fidelity, but with a peculiarly comical tone in the last word that caused great diversion amongst the audience.

Mr. BLADEN, senr., sang the well-known words in the patriotic song,

> Rule Britannia, Britannia rules the waves,
> Britons never, never, never shall be slaves!

The words were accurately repeated by the phonograph, though the musical *tones* were not reflected correctly. At the request of members the words of the song were repeated by the instrument, and they were delivered much as they would be if sung by a very drunken man.

Mr. BLADEN, senr., explained that when the same message was repeated it became less distinct at each repetition, through the impressions on the tinfoil being rubbed out or worn away.

The last experiment was with the following words, spoken in the tube by the Rev. Mr. Tenison-Woods: "I beg to propose a vote of thanks to Mr. Bladen for his very interesting exposition of this valuable instrument." These words were accurately and very distinctly repeated by the phonograph.

WEDNESDAY, 2 OCTOBER, 1878.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

CHARLES MOORE, F.L.S., in the Chair.

The minutes of the last meeting were read and confirmed.

Tho following gentlemen were duly elected ordinary members of the Society, viz. :—

John Newton, Darling Point.
Morrice A. Black, F.I.A., Australian Club.
F. J. Thomas, Hunter River N.S.N. Co., Market-street.
Marshall Smith, Oneby-gamba, Newcastle.
Alexander Dean, Elizabeth-street.
Thomas Edward Hewett, The Observatory, Sydney.
Robert Fraser, 12, Barrack-street.
Arthur Levett Jackson, Government Printing Office.
W. Rose, Merchant, O'Connell-street, Sydney.
Rev. Wm. Hey Sharp, St. Paul's College, University.
Augustus Berney, H.M. Customs, Sydney.
Ebenezer Macdonald, Oriental Bank.
E. Cyril Haviland, Ashfield.

The certificates of seven new candidates were read.

Seventy-four donations were laid upon the table.

Mr. W. A. DIXON, F.C.S., F.I.C., then read a paper on "The Deep Well Waters of Sydney."

WEDNESDAY, 6 NOVEMBER, 1878.

Ordinary monthly meeting of the Royal Society of New South Wales, held at the Society's Rooms, Elizabeth-street.

Hon. J. SMITH, C.M.G., M.D., V.-P., in the Chair.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz. :—

John Nowlan, Union Club, or "Eelah," West Maitland.
Thos. Augustus Ellis, C.E., 132, Pitt-street.
Rev. Robert Collie, Newtown.
Chas. Townsend Gedye, Eastbourne, Darling Point.
William Alfred Cottee, Spring-street.
Robert H. Burnett, C.E., Railway Department.
George Chas. Westgarth, Union Club.

The certificates of eight new candidates were read.

Forty-three donations were laid upon the table.

Mr. H. C. RUSSELL, B.A., F.R.A.S., then read a paper on "Some Results of an Astronomical Experiment on the Blue Mountains."

WEDNESDAY, 4 DECEMBER, 1878.

Ordinary monthly meeting of the Royal Society of New South Wales, held in the Society's Rooms, Elizabeth-street.

The minutes of the last meeting were read and confirmed.

The following gentlemen were duly elected ordinary members of the Society, viz. :—

W. H. Archer, F.I.A., London, Australian Club.
Edwin Henry Bestic, L.R.C.S., Ireland, L.R.C.P., Edinburgh, Arthursleigh-terrace.
William Chatfield, 69, Pitt-street.
Herr Kretschmann, Sydney.
Stephen Mallarky, Government Printing Office.
Duncan Mearns Maitland, jun., Elizabeth-street, Paddington.
Jules Meilhan, Victoria-terrace, Victoria-street.
James L. Ogilvy, Oriental Bank Corporation, Sydney.

The certificates of seven new candidates were read.

Nineteen donations (publications) were laid upon the table, also a special donation to the museum of the Society, namely a collection of two hundred and one species of land and marine shells, presented by John Brazier, Esq., C.M.Z.S.

A paper was then read by Mr. L. W. HART on "The Rise and Progress of Photography."

Mr. W. A. DIXON, F.C.S., F.I.C., read a paper entitled "Notes on Huan Island Guano."

Mr. H. C. RUSSELL, in the absence of the author, read a paper by Mr. J. P. Josephson on "Some Facts about the great Tidal Wave, May, 1877," at the conclusion of which—

Mr. CHARLES MOORE, F.L.S., one of the Vice-Presidents of the Society, informed the members that Dr. Leibius, one of the Honorary Secretaries, intended shortly to proceed on a tour to Europe, and would probably be absent at the next general meeting of the Society. Mr. Moore referred in very eulogistic terms to the services rendered to the Society by Dr. Leibius, and to the large amount of time and attention bestowed upon the Society's affairs by him, more especially since during the absence of Professor Liversidge, the joint Honorary Secretary, the whole of the duties of this office had fallen upon him.

The CHAIRMAN heartily indorsed all that was said by Mr. Moore, and a hearty vote of thanks to Dr. Leibius, coupled with best wishes for his intended journey, were passed by the meeting.

Dr. LEIBIUS, in thanking the two Vice-Presidents and the meeting for their very kind appreciation of his services to the Society, and their good wishes for his intended trip to Europe, assured them that, though the work of Honorary Secretary had, on account of the large extension and progress of the Society, very much

increased, he always looked upon it as a labour of love, and felt amply rewarded by seeing the Society steadily progress. The Society was now in correspondence and interchange of scientific publications with most of the principal scientific Institutions of Europe and America. Professor Liversidge, as one of the Honorary Secretaries, had certainly done the lion's share of the work when here, and great credit is due to him for the part he took in bringing about the new start the Society had taken during the last few years. While abroad, Professor Liversidge had been of much service to this Society in selecting books, and a very valuable microscope, &c. During this session of the Society, seventy-eight members have been elected; and it is hoped that, as the Society now consists of over four hundred members, a larger number of working members than hitherto will be forthcoming.

ADDITIONS

TO THE

LIBRARY OF THE ROYAL SOCIETY OF NEW SOUTH WALES.

DONATIONS—1878.

The names of the Donors are in *Italics*.

REPORTS, OBSERVATIONS, &c.

ADELAIDE :—The Adelaide University Calendar for the Academical Yea 1878. *The Registrar.*

Catalogue of Plants in the Government Botanic Garden, Adelaide, S.A.

Report of the Progress and Condition of the Botanic Garden and Government Plantations during 1877.
Dr. Schomburgk.

Meteorological Observations made at the Adelaide Observatory, January, February, March, and April, 1878. *The Observer.*

AUCKLAND :—Report of the Auckland Institute for 1877–78.
The Institute.

BOSTON, U.S.A. :—Memoirs of the Boston Society of Natural History.—Vol. II. Part 4. Nos. 5 and 6.

Proceedings of the Boston Society of Natural History :—
Vol. XVIII. Parts 3, 4.
Vol. XIX. Parts 1, 2.
The Society.

Proceedings of the American Academy of Arts and Sciences.—Vol. XIII. Part 1. *The Academy.*

BRISBANE :—Report of Board on Dr. Leaton's Minute *re* Quarantine and Medical Inspection.

A Bill "to amend" the Health Act of 1872.
L. A. Bernays, F.L.S.

BUFFALO :—Proceedings of the American Association for the Advancement of Science. Twenty-fifth Meeting, August, 1876.
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BRUSSELS :—Moniteur Industriel. Vol. V. No. 29, 10 October, 1878.
The Publisher.

CALCUTTA :—Memoirs of the Geological Survey of India—
Vol. XII. Parts 1, 2.
Vol. XIII. Parts 1, 2.

Do. do. (Palæontologia Indica.)
Series II. Parts 2 and 3.
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Series X. Parts 2 and 3.
Series XI. Parts 1 and 2.

Records of the Geological Survey of India—
Vol. IX. Parts 2, 3, and 4.
Vol. X. Parts 1, 2, 3, and 4.
The Superintendent of the Geological Survey of India.

CHRISTIANIA :—Some Remarkable Forms of Animal Life from the Great Deeps off the Norwegian Coast (with seven plates).
Enumeratio Insectorum Norvegicorum Fasciculus. II, III.
Oversight of Norges Araneider, by Robert Collett. I. Saltigradæ, Citigradæ (with four maps).
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Insecter og Midder (with four plates), by W. M. Schoyen.
Insecter og Smaakryb (with eight plates), by W. M. Schoyer.
Forhandlinger, 1 Videnskabs-selskabet i Christiania, Aar, 1874 (eight plates).
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Le Royaume de Norvége et le Peuple Norvégien, by Dr. O. J. Broch.
Quellen zur Geschichte des Taufsymbols und der Glaubensregel. III.
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Rejsckart over Norges, 5 sydlige stifter (two maps).
The Royal University of Norway.

DIJON :—Mémoires de l'Académie des Sciences, Arts et Belles Lettres de Dijon. Troisième Série. Tome quatrième. 1877.
The Academy.

DRESDEN :—Zeitschrift des K. Sachsischen Statistischen Bureaus—
Band XXII. Heft 1, 2, 3 und 4.
Band XXIII. Heft 1, 2, 3 und 4. *The Bureau.*
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Royal Academy of Natural Sciences.
Mittheilungen aus dem K. Zoologischen Museum zu Dresden.
Bericht über die Verwaltung der Königlichen Sammlungen für Kunst und Wissenschaft zu Dresden. 1874–75.
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Dr. Martin Luther's ersten und ältesten Vorlesungen über die Psalmen. Band I und II.
General-Direction der K. Sammlungen für Kunst und Wissenschaft zu Dresden.

DUBLIN :—Proceedings of the Royal Irish Academy—
Vol. II. Series II. Nos. 4, 5, 6.
The Transactions of the Royal Irish Academy—
Vol. XXV. No. 20.
Vol. XXXI. No. 1, 2, 3, 4, 5.
List of Council, Officers, and Members of the Royal Irish Academy, 31 July, 1876.
The Academy.

EDINBURGH :—Transactions of the Edinburgh Geological Society. Vol. III. Part 1. *The Society.*
Proceedings of the Royal Society of Edinburgh—
Session 1872–73.
Do. 1873–74.
Do. 1874–75.
Do. 1875–76.
Do. 1876–77. *The Society.*
Edinburgh Astronomical Observations. Vol. XIV. 1870–77. (22 plates.)
The Royal Observatory, Scotland.

FREIBURG :—Berichte über die Verhandlungen der naturforschenden Gesellschaft zu Freiburg i Baden. Band VII. Heft 1 und 2.
The Society.

GLASGOW :—The Glasgow University Calendar, 1878–79. *The Registrar.*

HAMBURG :—Verhandlungen des Vereins für Naturwissenschaftliche Unterhaltung zu Hamburg, 1871—1874.
1875, Band 11. *The Society.*

Mittheilungen der Geographischen Gesellschaft in Hamburg, 1876, 1877. *The Society.*

HAARLEM :—Archives Keerlandaises des Sciences exactes et Naturelles. Tome, XIII. Livraison 1, 2 and 3. *The Society.*

HEIDELBERG :—Verhandlungen des Naturhistorisch-Medicinischen Vereins zu Heidelberg, zweiter band erstes heft. *The Society.*

IOWA :—Proceedings of the Davenport Academy of Natural Sciences, Vol. II., Part I. *The Academy.*

JENA :—

Report from the Society of Natural History of Jena.
XI. Bd. N.F. 4 Bd. 3 Heft.
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XII. „ 5 „ 4 „ *The Society.*

LAUSANNE :—Bulletin de la Société Vaudoise des Sciences Naturelles. Vol. XV. Nos. 78, 79. *The Society.*

LIEGE :—

Annales de la Société Géologique de Belgique.
Tome II. 1874, 1875.
„ III. 1875, 1876.
„ V. 1877, 1878. *The Society.*

LUXEMBOURG :—Publications de l'Institut Royal Grand-Ducal de Luxembourg (Section des Sciences Naturelles). Tomes XV and XVI. *The Institute.*

LEEDS :—

The Yorkshire College of Science, Leeds, Calendar for 1877–8.
Third Annual Report of the Yorkshire College of Science, 1876–7. *The College.*

LILLE :—Société Géologique du Nord, 1870, 1874. Annales II, III, IV. *The Society.*

LIVERPOOL :—Proceedings of the Literary and Philosophical Society of Liverpool. No. XXXI. *The Society.*

LONDON :—

Proceedings of the Royal Society. Vol. XXVI. Nos. 179, 180, 181, 182, 183, 184, 185, 186, 187.
„ „ Vol. XXVII. Nos. 188, 189. *The Society.*

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List of the Linnean Society of London, 1877.

The Journal of the Linnean Society—
Botany. Vol. XVI. Nos. 93, 94, 95, 96, 97, 98.
Zoology. Vol. XIII. No. 72.
„ Vol. XIV. Nos. 74, 75. *The Society.*

Monthly notices of the Royal Astronomical Society. Vol. XXXVIII. Nos. 1, 2, 3, 4, 5, 6, 7, 8.

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A Catalogue of the Books in the Admiralty Library. *The Librarian.*

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Quarterly Journal of the Meteorological Society. Vol. III. Nos. 23, 24. *The Society.*

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The Journal of the Anthropological Institute of Great Britain and Ireland. Vol. VII. No. III. February, 1878.
„ Vol. IV. No. IV. May, 1878. *The Institute.*

Journal of the Royal Microscopical Society. Vol. I. No. 1.
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The Society.

Transactions of the Institution of Naval Architects, 1877. *The Librarian.*

Proceedings of the Royal Institution of Great Britain. Vol. VIII., Parts 1, 2, 3, 4. *The Institution.*

Proceedings of the Royal Geographical Society. Vol. XXII, Nos. 2, 3, 4, 5, 6. *The Society.*

Report of the Council of the Royal Colonial Institute, 28 June, 1878.

Proceedings of the Royal Colonial Institute. Vol. IX, 1877–78.

On Trek in the Transvaal. By Harriet A. Roche. *The Institute.*

Proceedings of the Physical Society of London. Vol. II, Part IV. *The Society.*

MANCHESTER :—Transactions of the Manchester Geological Society. Vol. XIX. Parts 14, 15, 16, 18, 19, 20, 21, 22. *The Society.*

MARBURG :—Sitzungsberichte der Gesellschaft zur Beförderung der Gesammten Naturwissenschaften in Marburg. 1866 to 1877 (inclusive).

Untersuchungen über Einseitig frei Schwingende Membranen, &c. By Carl Müller.

Untersuchungen über die Wirkung des Veranderten huftdrucks, &c. By Dr. Speck.

Uerber die zugleich gleicheckigen und gleichflachigen Polyeder. By Dr. E. Hess. *The Society.*

MASSACHUSETTS :—Bulletin of the Essex Institute. Vol. VIII, 1876.
Do. do. do. IX, 1877.

Essex Institute Historical Collections. Vol. XIII. Parts 3, 4. *The Institute.*

Dredging Operations of the U.S. Coast Survey Steamer "Blake." Letter No. 1, from Alex. Agassiz.

Annual Report Museum of Comparative Zoology. Harvard College, 1876. *The Museum, Harvard College.*

MELBOURNE :—Statistical Register of the Colony of Victoria, 1876.

Part VII—Interchange. Part VIII—Law, Crime, &c. Part IX—Religious, Moral, and Intellectual Progress.

Index for Statistical Register of the Colony of Victoria, 1876.

Statistics of Friendly Societies for the year 1876.

Statistical Register of the Colony of Victoria, 1877.
Part I—Blue Book. Part II—Population. Part III—Finance, &c. Part IV—Production. Part V—Vital Statistics. Part VI—Accumulation.

Index to Australian Statistics for year 1877.

Victorian Year Book for 1877–8. *The Government Statist.*

Reports of the Mining Surveyors and Registrars of Victoria, quarter ending 30th September, 1877.
Do. 31st March, 1878.
Do. 30th June, 1878.

Report of the Chief Inspector of Mines for 1877.

Mineral Statistics of Victoria for year 1877. *The Minister of Mines.*

Melbourne Medical Record. Vol. VII, No. 5. *The Publishers.*

MELBOURNE—*continued.*
The Melbourne University Calendar for the Academic Year 1877–78. *The University.*
Eucalyptus (different varieties) 11 Litho. Plates.
The Organic Constituents of Plants and Vegetable Substances. By Dr. G. C. Wittstein. Translated by Baron Ferd. von Müeller, C.M.G.
Proceedings of the Zoological and Acclimatisation Society of Victoria. Vol. V, 1878. *Baron Ferd. von Müeller, Government Botanist.*
Transactions and Proceedings of the Royal Society of Victoria. Vols. XIII, XIV. *The Society.*

MIDDLESBOROUGH :—Report on the Progress of the Iron and Steel Industries in Foreign Countries. 11. 1877.
Journal of the Iron and Steel Institute. No. 1, 1878. *The Institute.*

MONTPELLIER :—Mémoires de la section des Sciences. Tome IX. 1 Fasc., 1876. *The Academy.*

MULHOUSE :—Bulletin de la Société Industrielle de Mulhouse. January, February, March, April, May, June, July August, September, October, November, 1878. *The Society.*

MUNCHEN :—Abhandlungen der Mathematische—Physickalischen classe der Koniglich Bayerischen Akademie der Wissenschaften. XII, XIII. Band 1, 2, and 3, abtheilung.
Sitzungs berichte der Mathematisch—Physickalischen classe der k. b. Akademie der Wissenschaften.
Munchen, 1876. Heft 1, 2, 3.
Do. 1877. do. 1, 2, 3.
Monographie der Sapindaceen—Gattung Serjania (von L. Radlkofer.
Almanach der Koeniglich bayerischen Academie der Wissenschaften for 1878. *The Academy.*

NEUCHATEL :—Bulletin de la Société des Sciences Naturelles de Neuchatel. Tome XI. Premier cahier. *The Society.*

NEWCASTLE-UPON-TYNE :—Newcastle-upon-Tyne Chemical Society Transactions. Vol. III, 1874–7.
Do. Report of Committee. *The Society.*

OXFORD :—Radcliffe Observations, 1875. Vol. XXXV.
Radcliffe Library Catalogue of Books on Natural Science, up to December, 1872.
Additions to Radcliffe Library during 1873, 1874, 1875, 1876.
Catalogue of Transactions of Societies, Periodicals, and Memoirs.
Catalogue of Books added to the Radcliffe Library, Oxford University Museum, 1877. *The Radcliffe Trustees.*
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The Main Drainage of Oxford. By W. H. White, Assoc. Inst., C.E.
On the Mineral Water discovered in sinking the Artesian Well at St. Clement's, Oxford.
On the Rainfall for 25 years—1851–1875.
A new form of Polariscope, &c. *The Ashmolean Society.*

PARIS :—Etude sur les Ouragans de l'Hémisphère Austral. By M. Bridet.
Nouvelle Classification des Nuages.
Usage du Cercle Méridien Portatif, &c.
Meteorologie Nautique, Vents et Courants, Routes Générales.
Eight Maps. Nos. 3,381-4, 3495-8.
Directeur-Général du Depôt des Cartes et Plans.

PENNSYLVANIA :—Seventh Annual Report of the Board of Commissioners of Public Charities of the State of Pennsylvania.
The Board of Commissioners.

PHILADELPHIA :—Journal of the Franklin Institute. Vol. CIV, Nos. 623–624.
Do. Do., Vol. CV, Nos. 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635. *The Institute.*
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Catalogue of the Lepidoptera of America, North of Mexico. Part I. Diurnals. By William H. Edwards. *The Society.*
Proceedings of the American Philosophical Society. Vol. XVII, No. 100.
List of Surviving Members of the American Philosophical Society.
The Society.
Proceedings of the Academy of Natural Sciences of Philadephia. Parts I, II, III. 1877. *The Academy.*
Sixth Annual Report of the Board of Directors of the Zoological Society of Philadelphia. *The Society.*

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Società Toscana di Scienze Naturali, Processi Verbali, 13 January, 1878; 10 March, 1878; 5 May, 1878; 7 July, 1878.
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PLYMOUTH :—Annual Report and Transactions of the Plymouth Institution and Devon and Cornwall Natural History Society. Vol. VI, Part 1, 1876–7. *The Institution.*

ROME :—Atti della R. Accademia dei Lincei. Vol. I, fascicolo 1, 2, 3, 4, 5, 6, 7.
Do. Vol. II, fascicolo 1, 2, 3, 4, 5, 6, 7. *The Academy.*
R. Comitato Geologico d'Italia Bollettino. No. 5 E 6; No. 7 E 8.
The Society.

STOCKHOLM : — Kongliga Svenska Vetenskaps-Akademiens Handlingar (Memoires). Bd. 13 and 14.
Bihang Till K. Vet-Akad-Handl. Bd. 3.
Ofversigt af K. Svenska Vetenskaps Akademiens Förhandlingar Arg. 33, 1876.
Enumeratio Hemipterorum Bridrag Till en Förteckning Ofver alla Hittills Kända Hemiptera, &c., by C. Stael.
Iconographia Crinvideorum in Stratio Suecicæ Siluricis Fossilium, (29 plates.) *Royal Swedish Academy of Sciences.*

STUTTGART :—Württembergische Naturwissenschaftliche Jahreshefte—
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1871 ,, I, II, III.
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Festschrift zur Feier der Vierhundertjährigen Jubiläums der Eberhard-Karls-Universität zu Tübingen. 9th August, 1877, with 3 litho. plates. *The Editors.*

SYDNEY :—Proceedings of the Linnean Society of New South Wales—
Vol. II. Part 2, 4.
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The Society

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Geological Map of the Districts of Hartley, Bowenfels, Wallerawang and Rydal.

The Minister of Mines.

Blue Book, N.S.W., for the year 1877.

The Government Printer.

Flora Australiensis, by George Bentham, F.R.S., assisted by Baron von Müeller, C.M.G.

Fossil Remains of the Extinct Mammals of Australia, by Professor Owen.

The Colonial Secretary.

TASMANIA :—Papers and Proceedings of the Royal Society of Tasmania, 1876.

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,, British Islands, No. 6.

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201 Species of Land and Marine Shells, as per the following list :—
John Brazier, Esq., C.M.Z.S., &c.

Class. GASTEROPODA.

Family. Muricidæ.

1. Murex adustus, *Lam.* Philippine Islands.
2. ,, capucinus, *Lam.* North Australia.

Family. Tritoniidæ.

3. Triton rubecula, *Lam.* New Caledonia.
4. Persona anus, *Lam.* Red Sea.
5. Ranella granifera, *Lam.* Red Sea.

Family. Buccinidæ.

Sub-Family. Nassinæ.

6. Eburna (Zemira) Australis, *Sowerby.* Port Jackson Heads.
7. Nassapapillosa, *Linn.* Philippine Islands.

Family. Olividæ.

8. Oliva sanguinolenta, *Lam.* Solomon Islands.
9. ,, ponderosa, *Duclos.* Mauritius.
10. ,, cœrulea, *Bolten.* Sandwich Islands.
    episcopalis, Lam.
11. ,, tigrina, *Meuschen.* Torres Straits.
    tesselata, Lam.
12. ,, olivaceus, *Meuschen.* Panama.
13. ,, cruenta, *Solander.* Nosibe.
    emicator, Meuschen.
14. ,, irisans, *Lam.* Ceylon.
15. ,, porphyritica, *Martini.* New Caledonia.
    erythrostoma, *Lam.*
    porphyritica, dark variety. New Caledonia.
16. ,, elegans, *Lam.* Fiji Islands.
17. ,, ispidula, *Lam.* Cape York.
18. ,, maura, *Lam.* Fiji Islands.
19. ,, carneola, *Gmel.* ,,
20. ,, scripta, *Lam.* ,,
21. Scophula biplicata, *Sowerby.* California.
22. Olivina jaspidea, *Gmel.* West Indies.

Family. Fasciolarudæ.

23. Fasciolaria tulipa, *Lam.* West Indies.

Family. Volutidæ.

24. Voluta fusiformis, *Swainson.* Tasmania.
25. ,, vespertilio, *Linn.* Philippine Islands.
26. ,, Norrisi, *Sowerby.* Western Australia.
27. ,, Angasi, *Sowerby.* Tasmania.
28. ,, zebra, *Leach.* Port Stephens, N.S.W.
29. Mitra episcopalis, *Lam.* Aneiteum, New Hebrides.
30. ,, pontificalis, *Lam.* ,, ,,

Family. Columbellinæ.

31. Columbella varians, *Sowerby.* Sandwich Islands.
32. Engina mendicaria, *Lam.* Aneiteum, New Hebrides

Family. HARPIDÆ.

33. Harpa ventricosa, *Lam.* Solomon Islands.

Family. CASSIDIÆ.

34. Cassis canaliculata, *Lam.* Ceylon.
35. ,, testiculus, *Lam.* Cuba.

Family. DOLIIDÆ.

36. Malea pomum, *Linn.* New Caledonia.
37. Sycotypus ficoides, *Lam.* Philippine Islands.

Family. NATICIDÆ.

38. Natica conica, *Lam.* Port Lincoln.
39. ,, melanostoma, *Lam.* Singapore.
40. ,, millepunctata, *Lam.* Adriatic Sea.
41. ,, marochiensis, *Lam.* Flji Islands.

Family. TEREBRIDÆ.

42. Terebra dimidiata, *Lam.* Tahiti.

Family. CONIDÆ.

43. Conus marmoreus, *Linn.* New Caledonia.
44. ,, imperialis, *Linn.* Philippine Islands.
45. ,, pulicarius, *Brug.* Solomon Islands.
46. ,, figulinus, *Brug.* Philippine Islands.
47. ,, quercinus, *Brug.* Solomon Islands.
48. ,, amadis, *Mart.* Ceylon.
49. ,, textile, *Linn.* New Caledonia.
50. ,, aulicus, *Linn.* Ceylon.
51. ,, striatus, *Linn.* New Caledonia.
52. ,, geographus, *Linn.* New Caledonia.
53. ,, tulipa, *Linn.* Sandwich Islands.
54. ,, canonicus, *Brug.* Mauritius.
55. ,, maculatus, *Sowb.* Port Jackson.
56. ,, tessellatus, *Born.* Aneiteum, New Hebrides.
57. ,, catus, *Brug.* Loyalty Islands.
58. ,, miliaris, *Brug.* Sandwich Islands.

Family. STROMBIDÆ.

59. Strombus pacifica, *Sowerby.* Bampton Reef.
,, *Novæ Zælandiæ.* Chem.
60. ,, epidromus, *Linn.* New Caledonia.
61. ,, luhuanus, *Linn.* New Caledonia.
62. Chenopus pes-pelecani, *Linn.* British.
63. Pelicaria scutulata, *Mart.* Port Jackson.
64. Terebellum punctatum, *Lam.* New Caledonia.

Family. CYPRÆIDAE.

65. Cypræda lynx, *Linn.* Fiji Islands.
66. ,, Argus, *Linn.* Marshall Islands.
67. ,, exanthema, *Linn.* Tobago.
68. ,, pantherina, *Solander.* Red Sea.
69. ,, reticulata, *Mart.* Sandwich Islands.
70. ,, caput-serpentis, *Linn.* Fiji Islands.
71. ,, helvola, *Linn.* Bampton Reef.
72. ,, moneta, *Linn.* Tongataboo.
73. ,, annulus, *Linn.* Tongataboo.
74. ,, talpa, *Linn.* Andaman Islands.
75. ,, carneola, *Linn.* Kingsmill's or Marshall Island.
76. ,, arenosa, *Gray.* Paumotus Islands.
77. ,, mus, *Linn.* West Indies.

Family. CYPRÆIDAE—*continued.*

78. Cypræda caurica, *Linn.* Sandwich Islands.
79. „ xanthodon, *Gray.* New South Wales.
80. „ errones, *Linn.* Ceylon.
81. „ cylindrica, *Born.* New Caledonia.
82. „ isabella, *Linn.* Bampton Reef.
83. „ clandestina, *Linn.* Tongataboo or Tonga.
84. „ asellus, *Linn.* Tongataboo or Tonga.
85. „ felina, *Gmel.* Tongataboo or Tonga.
86. Trivia quadripunctata, *Gray.* West Indies.
87. Cyphoma gibbosa, *Linn.*
(*Ovulum gibbosum*, Lam.)

Family. CERITHIIDÆ.

88. Cerithium moniliferum, *Kiener.* New Caledonia.
89. „ lemniscatum, *Quoy.* New Caledonia.
90. „ stercus-muscarum, *Val.* Panama.
91. Vertagus obeliscus, *Brug.* New Caledonia.

Family. MELANUDÆ.

92. Melania setosa, *Swainson.* Solomon Islands.
93. „ acuta, *Lea.* Island of Guam.

Family. PALUDINIDÆ.

94. Paludina bengalensis, *Lam.* Mauritius.

Family. CAPULIDÆ.

95. Cochlolephas antiquata, *Linn.* Cape Solander, Botany Bay.

Family. NERITIDÆ.

96. Nerita polita, *Linn.* Solomon Islands.
97. „ albicilla, *Linn.* Solomon Islands.
98. Neritina nucleolus, *Morelet.* New Caledonia.
99. „ cornea, *Linn.* Solomon Islands.
100. „ zebra, *Lam.* Philippine Islands.
101. „ sumatrensis, *Sowb.* Solomon Islands.
102. „ pupa, *Linn.* Cuba, West Indies.
103. „ reticulata, *Brod.* Tahiti.
104. „ mertoniana, *Lesson.* Fiji Islands.
105. „ longispina, *Reclaz.* Philippine Islands.
106. Navicella porcellana, *Linn.* Solomon Islands.

Family. TROCHIDÆ.

107. Rotella elegans, *Beck.* Ceylon.
108. Clanculus pharonis, *Linn.* Madagascar.
109. Elenchus lineatus, *Lam.* Tasmania.
110. Trochus merula, *Chem.* Cape of Good Hope.
111. Gibbula strangei, *A. Ad.* Port Jackson.

Sub-Family. STOMATELLINÆ.

112. Stomatella imbricata, *Lam.* Port Jackson.
113. Gena strigata, *A. Adams.* Port Jackson.

Family. HALIOTIDÆ.

114. Haliotis cocco-radiata, *Reeve.* Port Jackson.

Family. FISSURELLIDÆ.

115. Lucapina incei, *Reeve.* Port Jackson.
116. Scutus elongatus, *Lam.* Port Jackson.

Family. Chitonidæ.

117. Lophyrus australis, *Sowerby*. Port Jackson.
118. Cryptoplax striatus, *Lam.* Port Jackson.

Family. Aplustridæ.

119. Bullina lineata, *Wood.* Port Jackson.

Family. Bullidæ.

120. Bulla ampulla, *Linn.* Port Jackson.
121. „ oblonga, *A. Adams.* Port Jackson.

Order.—PULMONIFERA.

Family.—Helicidæ.

122. Helix xanthocheila, *Pfr.* Solomon Islands.
123. „ lambei, *Pfr.* Duke of York Islands.
124. „ malantaensis, *Angas.* Solomon Islands.
125. „ boivini, *Petit.* Solomon Islands.
126. „ flexilabris, *Pfr.* Rubiana, Solomon Islands.
127. „ hargravesi, *Angas.* Bougaineville, Solomon Islands.
128. „ leucophæ, *Cox.* Guadalcanar, Solomon Islands.
129. „ ambrosia, *Angas.* Galera, Solomon Islands.
130. „ cleryri, *Petit.* San Christoval, Solomon Islands.
131. „ solitaria, *Say.* Ohio, United States of America.
132. „ louisiadensis, *Forbes.* Louisiade Islands.
133. „ maddoxi, *Brazier.* Solomon Islands.
134. „ fringilla, *Pfr.* Rubiana, Solomon Islands.
135. „ hunteri, *Cox.* Guadalcanar, Solomon Islands.
136. „ nemoralis, *Linn*, England.
137. „ iloconensis, *Sowerby.* Philippine Islands.
138. „ hombrani, *Pfr.* Ysabel, Solomon Islands.
139. „ grayi, *Pfr.* New South Wales.
140. „ launcestonensis, *Reeve.* Tasmania.
141. „ coxi, *Crosse.* Port Denison.
142. „ majuscula, *Pfr.* New Ireland.
143. „ vitatta, *Mull.* Ceylon.
144. „ cineracea, *Homb et Jacq.* Solomon Islands.
145. „ cereolus, *Muhl.* Florida, U.S. A.
146. „ sophiæ, *Gaskoin.* Lord Howe's Island.
147. Bulimus strangei, *Pfr.* Rubiana, Solomon Islands.
148. „ palmarum, *Mousson.* Galera, Solomon Islands.
149. „ san-christovalensis, *Cox.* Solomon Islands.
150. „ sellersi, *Cox.* Guadalcanar, Solomon Islands.
151. „ miltocheilus, *Reeve.* San Christoval, Solomon Islands.
152. „ dux, *Pfr.* King George's Sound.
153. „ dufresni, *Leach.* Tasmania.
154. „ zebra, *Mull.* Honduras, Cent. America.
155. „ luzonicus, *Sowerby.* Philippine Islands.
156. „ melo, *Quoy and Gaimard.* King George's Sound.
157. „ kingi, *Gray.* King George's Sound.
158. Partula gibba, *Fer.* Guam.
159. Achatina virginea, *Linn.* Cuba.
160. Achatinella vulpina, *Fer.* Sandwich Islands.
161. Pupa uva, *Linn.* West India Islands.

Family. Auriculidæ.

162. Auricula auris-judæ, *Linn.* Cape York.
163. Cassidula angulifera, *Petit.* Cape York.
164. Pythia argenvillei, *Pfr.* Fitzroy Island.
165. Melampus fasciatus, *Desh.* Solomon Islands.

ORDER.—OPERCULATA.

Family. CYCLOPHORIDÆ.

166. Pupina angasi, *Brazier*. New Guinea.
167. Hargravesia polita, *H. Adams*. Solomon Islands.

Family. HELICINIDÆ.

168. Helicina moquiniana, *Recluz*. San Christoval, Solomon Islands.

CLASS.—CONCHIFERA.

ORDER. PHOLADACEA.

Family. PHOLADIDÆ.

169. Barnea similis, *Gray*. Port Jackson.

Family. SOLENIDÆ.

170. Solen sloanei, *Gray*. Port Jackson.

Family. TELLINIDÆ.

171. Tellina virgata, *Linn*. Fiji Islands.
172. ,, scobinata, *Linn*. Philippine Islands.

Sub-Family. DONACINÆ.

173. Donax deltoides, *Lam*. Port Jackson.

Family. VENERIDÆ.

174. Chione lamellata, *Lam*. Tasmania.
175. ,, calophylla, *Hanley*. Port Jackson.
176. ,, alatus, *Reeve*. Port Jackson.
178. ,, scalarina, *Lam*. South Australia.
179. Tivela undulosa, *Lam*. South Australia.
180. Cytherea castrensis, *Lam*. Tongataboo.
181. Circe undatina, *Lam*. Port Jackson.
182. ,, pectinata, *Linn*. Port Curtis.
183. Tapes undulata, *Born*. Port Jackson.

Family. CARDIIDÆ.

184. Cardium lyratum, *Sowerby*. Tongataboo.
185. ,, unedo, *Linn*. Fiji Islands.

Family. LUCINIDÆ.

186. Lucina rugifera, *Reeve*. Port Jackson.

Family. MYTILIDÆ.

187. Lithodomus gracilis, *Lam*. Torres Straits.

Family. TRIGONIIDÆ.

188. Trigonia margaritacea, *Lam*. Tasmania.
189. ,, lamarcki, *Gray*. Port Jackson.

Family. ARCIDÆ.

190. Barbatia fasciata, *Reeve*. Port Jackson.
191. Axinia holoserica, *Reeve*. Port Jackson.

Family. PECTINIDÆ.

192. Pecten tegula, *Wood*. Port Jackson.
193. ,, pallium, *Lam*. New Caledonia.
194. ,, purpuratus, *Lam*. Panama.
195. Vola fumata, *Reeve*. Port Jackson.
196. Radula lima, *Linn*. Port Jackson.

Family. VOLSELLIDÆ.

197. Vulsella rugosa, *Lam.* New Caledonia.

Family. OSTREIDÆ.

198. Ostrea mordax, *Gould.* Port Jackson.

CLASS.—BRACHIOPODA.

Family. TEREBRATULIDÆ.

Sub-Family. TEREBRATULINÆ.

199. Waldheimia flavescens, *Lam.* Port Jackson.

Sub-Family. MAGASINÆ.

200. Magus cumingi, *Davidson.* Port Jackson Heads.
201. Kraussia lamarckiand, *Davidson.* Port Jackson.

191 mounted on glass tablets, 10 done up in paper.

EXCHANGES AND PRESENTATIONS

MADE BY THE

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In the following Lists the numbers refer to the under-mentioned publications:—

No. 1.—Journal of the Royal Society of New South Wales, 1877.
,, 2.—Remarks on the Sedimentary Formations of New South Wales, by the Rev. W. B. Clarke, M.A., F.R.S., &c.
,, 3.—Report of the Mining Department of New South Wales, 1877.
,, 4.—Report of the Commissioner for Railways of New South Wales, 1876.
,, 5.—Report of the Council of Education of New South Wales, 1877.

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Number of Publications sent to Great Britain ...	248
,, ,, ,, The Colonies (including India) ...	112
,, ,, ,, America	194
,, ,, ,, Europe	319
,, ,, ,, Asia (Japan) ...	4
Total (including Editors of Periodicals)	877

A. LIVERSIDGE, } Hon. Secretaries.
A. LEIBIUS, }

The Society's House, Sydney, August, 1878.

REPORTS FROM THE SECTIONS

(IN ABSTRACT).

REPORTS FROM THE SECTIONS.
(IN ABSTRACT.)

SECTION A.—ASTRONOMY AND PHYSICS.

PRELIMINARY MEETING—5 APRIL, 1878.

Mr. H. C. Russell, B.A., F.R.A.S., in the Chair.

After the confirmation of the minutes of the preceding meeting of the Section, the election of officers for the current year was proceeded with, and the following gentlemen were elected:—Chairman: Mr. H. C. Russell, B.A., F.R.A.S. Secretary: Mr. G. D. Hirst. Committee: Mr. H. G. A. Wright, M.R.C.S.; Mr. W. J. MacDonnell, F.R.A.S.; Rev. Geo. Martin, and Mr. J. U. C. Colyer.

It was resolved that the meetings of the Section for the present session should be held on the first Friday in each month.

3 MAY, 1878.

Mr. H. C. Russell, B.A., &c., in the Chair.

A paper was read from Mr. John Tebbutt, F.R.A.S., Windsor, entitled "Note on the Planet Uranus."

The Chairman read a paper on the "Longitude of the Sydney Observatory," and stated that as the longitude determined by him agreed very closely with that arrived at by comparison with Melbourne and Wellington (N.Z.) by telegraph, it would in future be assumed as the correct longitude of the Observatory.

Mr. G. D. Hirst quoted some remarks published by Mr. Bessemer in "Nature" on the construction of large silvered glass reflectors.

13 JUNE, 1878.

Mr. H. C. Russell, B.A., &c., in the Chair.

Mr. W. J. MacDonnell, F.R.A.S., read a paper on sundry forms of governors for telescope-driving clocks. He stated that he had not been able to place on record all that he had found on the subject, but that he hoped to finish the paper cn a future occasion.

A paper was read from Mr. John Tebbutt, F.R.A.S., Windsor, on the recent transit of Mercury. A supplementary paper was also read from the same gentleman on the result of a recent determination of the difference in longitude between his observatory and that of Sydney.

Mr. G. D. HIRST read a note on his personal observation of the remarkable meteor seen on the afternoon of the 1st June.

The CHAIRMAN exhibited a set of eye-pieces, manufactured by Hilger, of London, for the large equatorial at the Sydney Observatory, ranging from 150 to 1,200 diameters, the lenses being composed of quartz. He also exhibited a micrometer for the large spectroscope by the same maker.

A clock was exhibited, the invention of Mr. Barraclough, for producing a perfectly uniform motion in the revolving barrel of a chronograph. The governing power was produced by two pendulums swinging at right angles to each other.

5 JULY, 1878.

This meeting lapsed in consequence of the absence from town of several of the members.

2 AUGUST, 1878.

Mr. H. C. RUSSELL, B.A., &c., in the Chair.

A discussion took place in reference to the clock exhibited at the last meeting Mr. Russell stated that he had succeeded in greatly simplifying the attachment to the pendulums. The clock was being tried on a chronograph at the Observatory, and was giving very satisfactory results.

A paper was read from Mr. JOHN TEBBUTT, F.R.A.S., Windsor, on the star "Brisbane, 6183."

Mr. W. J. MACDONNELL, F.R.A.S., read a letter he had received from Mr. Neisson urging the establishment of a Selenographical Society in Sydney. He also read a paper on observatories in the United States.

The CHAIRMAN read a paper on "The Comparison to Sirius."

6 SEPTEMBER, 1878.

Mr. H. C. RUSSELL, B.A., &c., in the Chair.

The CHAIRMAN introduced to the notice of the members a new form of triangular micrometer, which he recommended as possessing many advantages over the old form of ring micrometer. It consisted of a metal triangle introduced into the diaphragm of the eye-piece, the base of the triangle being equal to its height.

Mr. G. D. HIRST exhibited some crayon drawings of Jupiter made during the present opposition; he read some notes on the most remarkable features presented by the planet at the present time.

Mr. W. J. MACDONNELL and the CHAIRMAN exhibited some new forms of microphones and apparatus.

4 OCTOBER, 1878.

Mr. H. C. Russell, B.A., &c., in the Chair.

A paper was read from Mr. W. J. MacDonnell, F.R.A.S., on star discs and the separating power of telescopes.

The Chairman read a paper on the results of the transit of Venus observations published by Captain Tupman.

1 NOVEMBER, 1878.

Mr. H. C. Russell, B.A., &c., in the Chair.

A paper was read from Mr. John Tebbutt, F.R.A.S., Windsor, on the "Geocentric Conjunction of Mars and Saturn on the 1st July, 1877."

The Chairman read a paper on the "Mounting of large Object-glasses." He also read a note on a new form of equatorial stand; it was accompanied by a model and working drawings. The model was inspected by the meeting, and the plan proposed met with general approval.

Note on the Planet Uranus.

By John Tebbutt, F.R.A.S.

[*Read before the Astronomical Section, 3 May, 1878.*]

A century has now almost elapsed since Sir William Herschel detected the planetary character of Uranus, and during that long period the planet has passed only once through its perihelion. This perihelion passage occurred about the close of last century. The planet, in consequence of its slow angular movement, comes into geocentric opposition to the sun once in every period of 370 days. Its nearest approach to the earth takes place, of course, about the time of the opposition, but it is obvious from a consideration of the eccentricity of the planet's orbit that the opposition-distance varies according to the distance of the planet itself from its perihelion. Without regarding the small variation due to the earth's distance from its own perihelion, it is also obvious that when the opposition takes place at the same time that the planet is in or very close to its perihelion the opposition-distance is at a minimum, and this is the most favourable opportunity for the telescopic examination of the planet and its satellites. Now this combination of circumstances will soon take place; the planet has, in fact, for the past forty years been gradually approaching the earth at each successive opposition. It will be remembered that in the newspapers I pointed out a somewhat similar circumstance in connection with the planet Mars previously to its opposition last year. The heliocentric longitude of Uranus at the last opposition (15 February, 1878) was 147° 25′, and that of the perihelion, according to Chambers's Descriptive Astronomy, 1867, p. 38, is 167° 30′, and as the heliocentric motion of the planet is at present about 4¾ degrees during a synodical period, it follows that the opposition of March, 1882, will fall the nearest to the perihelion during the present century. Adopting the planet's orbit-elements in Chambers's Astronomy, I get 18·2875 and 20·0780 respectively as the perihelion and aphelion distances expressed in parts of the earth's mean distance from the sun. The radii-vectores of the earth corresponding to the heliocentric longitudes of the planet's perihelion and aphelion are respectively 0·9932 and 1·0064. From these values I deduce therefore 17·2943 and 19·0716 as the minimum and maximum limits of the variation of the planet's opposition-distance. If now we assume Sir G. B. Airy's determination (R.A.S. Monthly Notices, Vol. XXXVIII. p. 16) of the sun's mean distance from the telescopic observations of the British Expedition for the Observation of the transit of Venus, 1874, namely, 93,375,000 miles, we have for the real minimum and maximum opposition-distances 1,615 and 1,781 millions of miles respectively,

giving a difference of 166 millions of miles. This difference certainly does not form a great proportion of the whole distance, but it is sufficient to indicate that Uranus is now in the most favourble part of its orbit for telescopic observation, and this favourable combination of circumstances will increase till 1882, after which it will diminish.

Another result of the conditions I have thus pointed out is the fact that the planet is becoming more distinct to the naked eye at each successive opposition. It can, even now that several weeks have elapsed since its opposition, be distinctly seen without a telescope. At the present time it is nearly on the same meridian of right ascension with Nu (ν) Leonis, and about forty-five minutes of arc north of that star. Both stars being embraced within the field of the finder of my equatorial, I had a good opportunity last evening, April 24th, of comparing their relative brilliancy. The objects appeared to be exactly equal: if there was any difference, the inferiority was perhaps with the planet. The British Association Catalogue of 8,377 stars for 1850 and the U. S. Naval Observatory Catalogue of 10,658 stars for 1860 both give $5\frac{1}{2}$ as the magnitude of ν Leonis, so that Uranus may certainly be regarded as a large star of the sixth magnitude. My attention was not directed to the planet at the time of its maximum brilliancy in February last.

In February, 1869, I observed the planet on the meridian with the transit instrument, and found it to be very nearly fifteen seconds of time west of the place assigned to it by the old Tables of Bouvard, which have been employed in the computations of the Nautical Almanac down to the end of 1876. Observations taken last evening, however, showed it to be almost precisely in the place deduced from Professor Newcomb's new Tables since employed for the Ephemeris in the Nautical Almanac.

Observatory, Windsor, 25 April, 1878.

On the Longitude of Sydney Observatory.

By H. C. Russell, B.A., F.R.A.S.

[Read before the Astronomical Section, 3 May, 1878.]

The members present this evening are probably all aware of the extreme difficulty of finding the longitude by astronomical observations alone, that is, by observations of the moon's change of position, due to her motion. To those who have not been in the habit of discussing lunar observations, it may be worth while to say that an error made in observing the moon's right ascension (taking the moon's average change in right ascension) is magnified some twenty-five times in the resulting error of longitude; thus, an error of observation of the moon of only one-fifth of a second would produce an error of 5s. in the longitude, and if the observation were made when the moon was changing her right ascension slowly the error would be much greater. All the refinements of modern instruments are required for such delicate work as the determination of longitude from observations of the moon; but there are other obstacles in the way which are still more difficult to overcome than the adjustments of instruments; foremost amongst these is the remarkable peculiarity amongst observers of the moon pointed out by the Astronomer Royal so long since as 1848, which might, I think, be called lunar personality. During that year it was found that between Mr. Dunkin and Mr. Breen, two of the Greenwich observers using the altazimuth, there existed a difference of 0.38s. in determining the moon's right ascension; and the Astronomer Royal remarks:—

"The circumstances under which the large errors given by Mr. Breen occurred were so various, in respect of moon's age and moon's position in her orbit, and the intermixture of the observations had been so complete that there was no doubt whatever that this was the result of a difference in the mode of observation.

"And this was not the result of personal equation usually so called; for it was known from the investigations of personal equation as exhibited in the clock errors given by stars (which are confirmed by similar investigations made to the end of 1849) that the personal equation was small. Neither was it a different estimation of the moon's diameter, for the difference of errors of moon's R. A. is nearly the same, and in the same direction, whether the first limb or the second limb be observed. It is strictly speaking a difference between the personal equation for the moon and that for the stars; or, it may be thus stated, that the duration of the impression on the nerves of the eye, or the time occupied in bringing into comparison the impressions on the

eye and on the ear, is not the same when the moon is observed with the eye as when a star is observed with the eye. The evidence of this is given in the following numbers :—

"By observations of the first limb of the moon from 1847, May 16, to 1848, May 28 :—

The mean of 45 errors of moon's tabular R.A., by Mr. Dunkin, is	plus 0·53 secs.
The mean of 35 errors, by Mr. Breen is......	plus 0·99
Excess of Mr. Breen	plus 0·46 secs.

"By observations of the second limb of the moon through the same period :—

The mean of 33 errors by Mr. Dunkin is ...	plus 0·50 secs.
The mean of 27 errors by Mr. Breen is......	plus 0·80 secs.
Excess of Mr. Breen	plus 0·30 secs."

—Introduction, "Greenwich Observations, 1848," page 70.

Here then we have a difference between observers which would make a difference of about 10·00 secs. of time in the longitude; and a careful examination of all the moon observations at Greenwich by Mr. Dunkin, and published in the R. A. S. Notices, vol. 19, page 259, revealed the fact that no two of the observers had the same personality in observing the moon. I have mentioned this fact in explanation of a suggestion I have to make to-night on the cause of the difference in the longitude of Sydney Observatory, as determined by the Rev. W. Scott and myself—a difference which appeared as soon as I began to take the observations in 1863.

The longitude of Sydney Observatory now used was determined by the Rev. W. Scott from 48 observations of the moon, taken during 1859, 1860, and 1861, and compared with observations taken on the same days at Greenwich, or the Cape of Good Hope. The resulting longitude was 10h. 4m. 45·79s., which has ever since been used as 10h. 4m. 46s. Mr. Stone, the Astronomer Royal at the Cape, from observations selected from the abovy (equal numbers of both limbs), found the longitude of Sydnee 10h. 4m. 47·32 secs. In 1863 I obtained a large number of observations of the moon, and, fortunately, for 36 of them, correspond ing ob servations at Greenwich ; from all these the longitude derived was 10h. 4m. 50·50s. During 1864 to 1870 inclusive Mr. Smalley did not observe for longitude. In 1871 I again observed, and had twenty-four corresponding observations from Greenwich, the mean of which gave 10h. 4m. 50·91s. for the longitude of Sydney. In 1872 the number of comparisons between Sydney and Greenwich from cloudy weather and other causes was only seven, giving for this year a mean longitude of

10h. 4m. 51·08s. In 1873 fourteen comparisons were obtained, and the mean longitude derived was 10h. 4m. 51·07. In 1874 thirteen comparisons were obtained, and the mean longitude derived is 10h. 4m. 50·47. For subsequent years I have not yet received the moon observations from Greenwich. We have then, as the result of my own observations compared with corresponding observations at Greenwich—

		h.	m.	s.
1863	...	10	4	50·50
1871	...			50·91
1872	...			51·08
1873	...			51·07
1874	...			50·47
Giving a mean		10	4	50.806

which differs by 5·01s. from that determined by the Rev. W. Scott, although the same instrument and method of observation were used by both of us; and it is therefore obvious that between the Rev. W. Scott and myself there is a personal equation when observing the moon different from that between us when observing stars. Just as has been found to be the case at Greenwich, the quantity is really a very small one—only 0·20—which produces this difference of 5s. in the longitude, and I am not surprised to find it; for between us, when observing stars, there was a difference of 0.37s.

It must not, however, be forgotten that there is very great difficulty in determining the moon's position, and the observations made at Greenwich on all possible occasions for determining the moon's true place for comparison with the Nautical Almanac predictions, vary in a very remarkable degree, and prove beyond question that extreme care is necessary in observing the moon.

Now, turning to other sources for data upon the longitude of Sydney, we have first and most important, the longitude of Melbourne; this, Mr. Ellery has found from a large number of moon observations to be 9h. 39m. 54·80s.; a very careful determination of the difference in longitude between the two observations by means of the telegraph lines makes it 24m. 55·77s., and this added to 9h. 39m. 54·80s. gives us 10h. 4m. 50·57s. as the longitude of Sydney.

In 1874, Major Palmer, while in New Zealand with the Transit of Venus Expedition, found the longitude of Wellington, New Zealand, to be 11h. 39m. 4·81s. and as soon as the New Zealand cable was laid the Cable Company courteously placed the cable at our disposal for the purpose of determining the difference of longitude between Sydney and Wellington, the cable being connected with the land lines at each end, so that the signals went

from one observatory to the other without interruption. Signals were therefore exchanged between the Venerable Archdeacon Stock, B.A., and myself, with the following result:—From Wellington to Sydney, 1h. 34m. 15·35s.; Sydney to Wellington, 1h. 34m. 16·64s. But it appears that the signals received at Wellington from Sydney were received by an assistant, whose cry as soon as he saw the signal from Sydney, was compared with the clock by Archdeacon Stock, and I quite agree with the view of Archdeacon Stock—that in such a process time must have been lost, and it does not appear that any attempt was made to determine how much was so lost; as the signals were received and recorded on the chronograph at Sydney by one observer, it is more than probable that the result so obtained is the more correct of the two. I therefore adopt, as has been done by Archdeacon Stock, 1h. 34m. 15·35s. as the difference between Sydney and Wellington observatories, and subtracting this from Major Palmer's longitude, we have 10h. 4m. 49·46s. as the resulting longitude of Sydney. We thus have four values of the longitude of Sydney.

	H.	M.	S.
Rev. W. Scott	10	4	45·79
Mr. Russell			50·81
Mr. Ellery (Melbourne)			50·57
Major Palmer (New Zealand)			49·46

And I have no doubt that these differences may all be accounted for by personality in observing the moon, and the question is naturally asked which is right, but it is impossible to say, and the question must, I fear, be left unanswered until the difference shall have been determined by the use of the telegraph lines. It is very much to be regretted that the various transit of Venus' parties did not combine and do this important work when they were in the Pacific Ocean. Probably it will be long before such a number of trained observers will be again on the spot to do this work, and the cost of doing it now would be considerable.

I have only to say in conclusion that in future the longitude of Sydney Observatory will be assumed to be 10h. 4m. 50·81s.

Note on the Transit of Mercury, on May 6th, 1878.

By John Tebbutt, F.R.A.S.

[*Read before the Astronomical Section, 13 June, 1878.*]

A transit of Mercury across the sun's disc occurred on the 6th of May last, *astronomical time.*—The ingress took place before the sun rose, so that the early part of the transit was not seen here. Owing to the presence of clouds the egress, unfortunately, was not completely observed by me. The fog having cleared off and the clouds having partially removed, I obtained the first view of the planet about 19h. 58m. with my 3¼-inch refractor. At this time I thought I could perceive a faint whitish spot on the planet's disc, but I could see nothing of the kind shortly afterwards with the 4½-inch equatorial. The latter telescope, provided with Cooke's prismatic reflecting eye-piece and a magnifying power of 180 diameters, was employed in the observation of the egress. The sun was free from spots, and there was no ring or halo round the planet when on the sun's disc, nor could I detect anything like a satellite. At 20h. 48m. 19·3s. observatory mean solar time, when I estimated the thread of light between the limbs of the sun and planet to be about a second of arc in breadth, the planet suddenly threw out a narrow ligament and immediately became somewhat pear-shaped, as represented in figure 1. The appearance at this time reminded me very much of that observed by Mr. Dunkin at Greenwich with the 3¾-inch alt-azimuth during the egress of the planet in November, 1868, and represented in his diagram on page 12 of the 29th volume of the Royal Astronomical Society's Monthly Notices. The ligament observed by me was nearly as black as the planet itself, and rendered it very difficult to estimate the time of the geometrical or apparent internal contact of limbs. This phase occurred about twenty-two seconds after the formation of the ligament, or at 20h. 48m. 41·3s. It appears from the *Sydney Morning Herald* of May 8th that the times of the internal contact as observed at the Sydney Observatory by Messrs. Russell, Hirst, and MacDonnell, were respectively 20h. 49m. 43·09s., 20h. 49m. 52·04s. and 20h. 50m. 3·67s. The apertures of the telescopes employed in these observations were respectively, 11½, 7¼, and 4¼ inches. Their times correspond to 20h. 48m. 13·05s. 20h. 48m. 22·00s. and 20h. 48m. 33·63s. at my observatory. Taking into consideration the fact that the differential effect due to parallax is in this instance almost inappreciable, it will be seen that my estimation of the geometrical contact agrees best with Mr. MacDonnell's observation, and it will also be noted that our telescopes had almost precisely the same aperture. What, however, seems to

Fig. 1.

Fig. 2.

me anomalous is the circumstance that the earliest estimation of the geometrical coincidence of limbs should have been made with the largest telescope, and the latest with the smallest telescope. Considering the small difficulty which the observers encountered with regard to the ligament, one might suppose that the order of the estimated contacts at Sydney would have been precisely the inverse of that stated to have been observed. The diminishing thread of light between the limbs should have been seen last by the largest telescope. The anomaly may, perhaps, be explained by a consideration of the magnifying power of the eye-pieces employed in the observations. The order of the observed external contacts is what one might expect in accordance with the various apertures. At 20h. 49m. 0·3s. Windsor mean time, I noted the appearance of the planet to be that shown in figure 2, which is similar to that given by Mr. Criswick in his observations, on page 13 of the Royal Astronomical Society's Monthly Notices already cited, the sun's cusps being rounded. I estimated the central bisection of the planet by the limb at 20h. 50m. 14·3s. Owing to the clouds becoming suddenly thicker and rendering the objects indistinct, I was unable to observe the external contact with satisfaction.

[Diagram.]

Note on the Star "Brisbane, 6183."

By John Tebbutt, F.R.A.S.

[Read before the Astronomical Section, 2 August, 1878.]

While engaged last evening in micrometer observations of stars in the neighbourhood of the Variable which I discovered in the constellation Ara in November last, I was struck with the fact that Brisbane, 6183, a star recorded at Parramatta between the years 1822 and 1826 as of the seventh magnitude, had either disappeared or become almost invisible in my equatorial of 4½ inches aperture. I succeeded in identifying the stars numbered 6142, 6172, 6177, 6181, 6196, and 6220 in the Brisbane catalogue, but the only stars now to be seen in the catalogued position of 6183 are two or three excessively faint ones. They are barely distinguishable in my telescope even on a brilliant sky with the moon absent, and it is therefore impossible to determine their position with the micrometer; this, however, might be done with the 11⅓-inch refractor of the Sydney Observatory. It is quite possible that the catalogued position of 6183 may be an erroneous observation of 6196, the right ascension being almost exactly two minutes of time too small. The south polar distances in the catalogue agree within a fraction of a second.

The non-appearance of the star may be thus accounted for, but in the meantime it will be well to record the fact in the Proceedings of the Astronomical Section of the Royal Society. The star is not to be found in Lacaille's catalogue.

Windsor, June 28th, 1878.

Notes on Observatories in the United States.

By W. J. MacDonnell, F.R.A.S.

[Read before the Astronomical Section, 2 August, 1878.]

I have recently received Messrs. André and Angot's work on Observatories in America, "L'Astronomie Pratique et Les Observatoires en Europe et en Amérique, 3^{me} partie, Paris, 1877," in which the marvellous success of astronomical pursuits in that country, and present high position of the science in the United States, are graphically described; and perhaps this Section will kindly bear with me whilst I make a few remarks on the subject. To the student of astronomy in Australia the lesson taught by the past experience of the States is one of great interest, and one from which we ought to gain much in advancing our favourite science.

The progress of astronomy in North America was at first very slow. No results worthy of record are noted during the eighteenth century, with the exception, perhaps, of a few observations of the transit of Venus, 1769; and, in spite of the advocacy of John Quincy Adams and others, Congress was decidedly opposed to the construction or maintenance of a permanent astronomical observatory.

The first attempt to found an observatory worthy of the name was that of Professor A. Hopkins, in 1836, in connection with the Williams College, Massachusetts, soon after the apparition of Halley's comet in 1835. Other observatories soon followed, viz., the Hudson Observatory, Western Reserve College, Ohio, 1838, and the Philadelphia High School, 1840, and the first State observatory—that of the military college of West Point—was completed in the same year. Astronomy had by this time taken a firm hold in the States, and Congress withdrawing its objections, the magnificent national observatory at Washington (now known as the United States Naval Observatory) was commenced; and although little more than thirty years have elapsed since its existence, it now ranks as a worthy peer of the grand observatories of Europe, and is a brilliant instance of the commendable perseverance towards success of American astronomers. I will now pass on to the erection of the Cincinnati Observatory. In 1842 the late Professor O. M. Mitchell gave a series of lectures on astronomy (since republished under the title of "Orbs of Heaven," one of the most fascinating astronomical works ever printed). The enthusiasm raised by this course of lectures was promptly availed of by Mitchell, and a Cincinnati Astronomical Society was formed, the object of which was to furnish the city with an observatory. $11,000, in shares of $25 each, were subscribed, a site was given by a citizen, and Mitchell was deputed to visit Europe for the

purchase of a telescope. He secured one at Munich of twelve inches aperture—one of the finest then in existence—at a cost of \$9,500. The observatory was completed in 1845, and at once began a career of usefulness which reflected honor both on founders and managers. The next observatory to come under our notice is that of Harvard College, Cambridge, Massachusetts. This is perhaps the most famous of all the American "Light-houses of the skies," as J. Q. Adams calls them. A meeting of the leading citizens of Boston was held in March, 1843, to determine on the construction of an observatory. The question was settled in the affirmative, and \$20,000, to defray expenses, were at once subscribed. It is a noteworthy fact that several Insurance Companies were subscribers for considerable sums. The observatory was built on ground purchased by the Harvard University, a splendid refractor of 15 inches aperture (then only equalled by the Pulkova telescope) procured, and active operations, under the guidance of the two Bonds, were begun in 1847. It is unnecessary to recapitulate the splendid services rendered to astronomy by the magnificent observatory, which is still in active operation.

Another well-known observatory, that of Dartmouth College, Hanover, New Hampshire, founded in 1853, is due principally to the liberality of one individual, Dr. G. Shattuck, who supplied the means for the acquisition of the site, purchase, and construction of the necessary instruments. This observatory is now under the direction of Mr. C. A. Young, who utilizes the $9\frac{1}{2}$-inch Alvan Clark equatorial in spectroscopic researches.

In 1860 a certain number of the inhabitants of Pittsburg and Alleghany city, Pennsylvania, undertook to provide an observatory for that city. A 13-inch equatorial was secured and the erection of a suitable building was commenced; but funds failing, the whole was about to be seized for debt, when a rich citizen of Pittsburg, Mr. William Thaw (*qy.* Shaw), paid the debt due and completed the observatory, at a cost of \$40,000. To secure the future of the observatory, he handed it over to the University of Pittsburg (Western University), with the sole condition that an efficient astronomer should be provided for by the University. Professor Langley, so well-known for his solar studies, is now in charge of this fine observatory. A curious event has happened to Professor Langley since his installation, and one fortunately without precedence in the annals of astronomy. During the night of the 8th of July, 1872, a thief broke into the observatory and stole the fine 13-inch object-glass of the equatorial. After some search it was found in the possession of a broker, who stated that he had purchased it from an unknown person. Luckily it had not sustained much damage, and on being retouched by Alvan Clark, is now one of the finest glasses extant.

In December, 1862, the Professors of the University of Dearborn, Chicago, having learnt that Fitz, of New York, had a fine objective of 14½ inches for sale, started a subscription for its purchase, and succeeded in getting $20,000. A Mr. Moyne was deputed to negotiate the purchase of the object-glass, but hearing *en route* that Alvan Clark had a splendid equatorial of 18½ inches aperture, and 23 feet focal length, on his hands, ordered by the University of Mississippi, but owing to the war of secession, the University was unable to complete the purchase, Mr. Moyne at once secured the 18½-inch, at a cost of $18,000, completely mounted. A wealthy public-spirited citizen of Chicago, Mr. J. Y. Scammon, promptly came forward with funds necessary for the installation of the telescope and the support of an observer.

The city of Albany (State of New York) possesses a first-class observatory, also founded by private means. The total cost was over $200,000, of which Mrs. Dudley contributed $105,000 in the name of her deceased husband, and hence the managers of the establishment have given it her name—"The Dudley Observatory."

Within the last few years, the United States Naval Observatory has added to the already fine collection of instruments it possesses, a refractor by Alvan Clark, the object-glass of which is 26 inches in diameter, exceeding by 1 inch the great Newall refractor, made by the eminent English maker, the late Thomas Cooke. But even with this magnificent telescope American ambition is not satisfied; for finding that Vienna is on the point of obtaining a 27-inch achromatic by Grubb, of Dublin, a still larger one must be secured. Mr. James Lick, of California, has devoted $700,000 for the establishment of an observatory, to be furnished with the largest telescope procurable. Mr. M'Cormick, of Chicago, has announced his intention of founding an observatory in connection with the University of Virginia, to contain amongst other instruments a 26½-inch equatorial. And finally, Alvan Clark and Sons have a disc of glass from Feil (of Paris) in hand for an object-glass of 29·8 inches aperture, which Mr. Winchester is having made for New Haven, at his expense.

The private observatories of Rutherfurd, Draper, Burnham, and other astronomers need not be specially described. They are fully detailed in Messrs. André and Angot's work.

Now is there anything in the history of American astronomy which is applicable to us in Australia? With the exception of the three Government Observatories, viz., Washington, Westpoint and Annapolis (the latter a mere adjunct to the naval school established for the instruction of junior officers), all the observatories in the States are due to private enterprise, either in the shape of a public subscription or to individual liberality. There is no appeal to the national Government for aid, and I am sure

our worthy Chairman will testify that much of the recent advance in astronomy is due to our American cousins. We have in Sydney, Melbourne, and Adelaide, observatories provided with fine instruments, thanks to the openhanded liberality of our colonial Governments, to whom all honour is due for their support of science in these young countries, but ought no effort be made to procure a thirty or forty inch telescope for this colony? Have we no wealthy citizens desirous of emulating the example furnished by their *confrères* in the States and establish an observatory with a giant telescope? And, again, when small cities in the States, such as they were thirty or forty years ago, determined to have their own observatories, with as large telescopes as were then procurable, why cannot we do the same here? Let our Section originate, and our Society sanction, an appeal to the public for the funds to procure one of the powerful instruments now in vogue. I merely broach the idea (probably premature) for the consideration of the Astronomical Section of the Royal Society.

Another thing may be considered: when the demand for large telescopes commenced in America, Alvan Clark and Sons, Fitz-Young and others, came forward to supply the wants of the community. The quality of the work performed by these makers may be judged from the fact that not only have they supplanted foreign opticians in their own country, but their instruments (especially those of the Clarks) are sought after by English observers. Who knows then, but that should a local demand arise, the same results will follow, and some Australian Alvan Clark, or a Cooke, or a Grubb, emerge from his obscurity and find a fitting field for his talents.

LIST OF THE MORE IMPORTANT OBSERVATORIES IN THE UNITED STATES.

Government.	Equatorial.
U. S. Naval Observatory ...	26-inch.
Westpoint do.	9¾ ,,
Annapolis do.	7¾ ,,
Private Observatories.	
Cincinnati	12 ,,
Dudley	13 ,,
Mr. Burnham's	6 ,,
,, Rutherford's	13 ,,
Dr. Draper's (reflectors)	15½·30 ,,
Projected Observatories.	
Mr. M'Cormick's	26½ ,,
,, Winchester's	29·8 ,,
,, Lick's	...
The Glasgow University ...	12¼ ,,

University and College Observatories.	Equatorial.
Williams College... ...	7-inch.
Western Reserve ...	4 ,,
Philadelphia High School	6 ,,
Georgetown College ...	6 ,,
Harvard do.	15 ,,
Tuscaloosa University ...	8 ,,
Amhurst College... ...	7¼ ,,
Shelly do....	7½ ,,
Hamilton do.	13½ ,,
Dartmouth do.	9½ ,,
Michigan do.	12½ ,,
Alleghany do.	13 ,,
Scientific School, Sheffield	9 ,,
Dearborne University, Chicago...	18½ ,,
Alfred Centre	9 ,,
Lehigh University ...	5 ,,

Clark's Companion of Sirius.

By H. C. Russell, B.A., F.R.A.S.

[*Read before the Astronomical Section, 2 August, 1878.*]

Several communications have appeared in *Nature* upon this interesting object, which was discovered in January, 1862, and found then by Bond to have an angle of 85°·1 and distance 10″·4. Few measures have been taken of it since, and in a communication to *Nature*, March, 1876, Mr. Wentworth Erck says he cannot estimate the angle at more than 55°, and that it is getting less, as required by Dr. Auwer's theory of a dark body revolving about Sirius and causing its anomalous proper motion. The following calculated and observed positions will be interesting. (In part copied from *Nature*.)

Year.	Computed on Dr. Auwer's Theory. Angle.	Distance.	Measured. Angle.	Pos. Dist.	Observer.
	°	″	°		
1862	85·4	10·10	85·1	10·4	Bond.
1865	79·9	10·78			
1868	75·0	11·15			
1871	70·3	11·20			
1872·25			63·0	10·6	Washington.
1874	65·5	10·95			
1874·18			59·0	10·5	
1875·24		10·59	56·6	10·0	
1876	62·1	10·59	55·0	10·97	Russell.
1876·30			55·0	...	Erck.
1877·97			52·4	10·83	Burnham.
1878	58·4	10·05			
1880	54·2	9·33			

From this table it is obvious that since 1862 the companion has not followed exactly the computed orbit, the angle being now about 6° less than theory requires; nevertheless it comes so near to the path which theory requires the companion to take, that there can be no doubt that it is this apparently insignificant companion which causes the observed irregularities in the proper motion of Sirius. Dr. Auwer's theory requires the companion to be 6·71 times as large as our Sun and Sirius himself 13·76 times. Yet though about half the size, it shines with a light almost infinitely less than that of Sirius. What can be the cause of such a difference it is hard to conjecture, and it does not seem probable that the spectroscope will aid us in answering the question. The spectrum of Sirius has been frequently examined, but there is so much light about the primary that there seems no hope of catching the faint rays from the companion; (estimated at 10 magnitude) in the presence of such splendour.

I have frequently been struck when observing Sirius with the planet-like disc of the companion, and I find that on the 7th March, 1876, I have made this note :—"Small star appears as a hard clear disc outside the rays of the large star."

The following measures have all been taken by me with the large equatorial.

MEASURES of the close companion (Clark's) of Sirius, made with the 11⅓in. equatorial, power 280.

Date.	Distance.		Angle.	Remarks.
	Mic.	"	° ′	
28 Dec., 1875...	0·616	11·02	54· 6	Fine night; definition good.
	0·590	10·57	55·16	
	0·624	11·19	55·14	
	0·650	11·65	55· 5	
	0·610	10·93	54·46	
Means		11·07	54·53	

February 17, 1876. Measures of Sirius with 11⅓, power 280.

Date.	Distance.		Angle.	Remarks.
	Mic.	"	° ′	
17 Feb., 1876...	0·644	11·55	54·10	Fine clear night after cloudy weather; definition moderately good.
	0·636	11·40	55·14	
	0·652	11·69	54·30	
	0·639	11·46	55·10	
	0·634	11·37	55· 5	
	0·643	11·53	54·40	
	0·648	11·62	54·35	
		11·52	54·46	

March 7, 1876. Measures of Sirius, 11⅓, power 200.

Date.	Distance.		Angle.	Remarks.
	Mic.	"	° ′	
7 March, 1876...	0·556	9·94	55·40	Light haze over the sky; definition good; small star appears as a hard disc outside the rays of the large star. Haze for a time hid small star and interferes with observations.
	0·571	10·23	54·54	
	0·567	10·16	55·30	
	0·588	10·54	55· 5	
	0·605	10·84	55·18	
	0·568	10·18	54·58	
		10·31	55·14	

April 5, 1876. Measures of Sirius, 11⅓, power 180.

Date.	Distance.	Angle.	Remarks.
		° ′	
5 April, 1876...	(See remarks.)	55· 2 54·57 55·57 54·54 54·37 55· 4 ——— 55· 5	Fine calm night, but very much smoke about. Measures of distance not satisfactory.

The Triangle Micrometer.

By H. C. Russell, B.A., F.R.A.S.

[Read before the Astronomical Section, 6 September, 1878.]

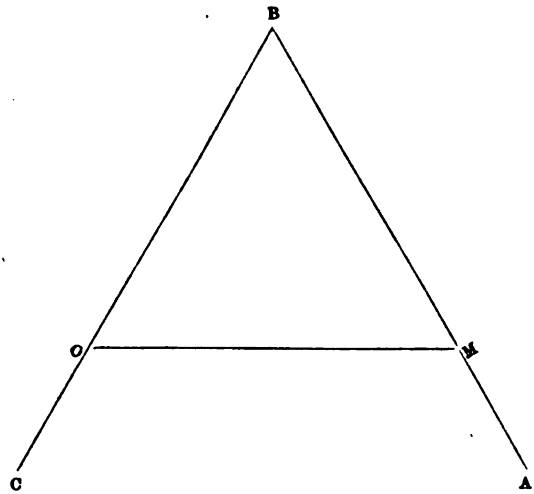
Most observers who have had to observe the positions of small bodies, comets for instance, have learned to dislike the ring micrometer; for although it gives differences of time with tolerable accuracy, the differences in declination are most unsatisfactory when found and very troublesome to compute; when therefore I had occasion to use it recently the old feeling of dissatisfaction came back to me, and set me thinking whether some more convenient form might not be devised, and the result I propose to lay before you to-night.

You are aware that Lacaille's observations at the Cape were made with rhomboidal figures, that is, two triangles base to base in the focus of the object-glass of the telescope. This form is much more satisfactory and convenient than the ring, yet I cannot find that any one has suggested its use in preference to the ring, nevertheless the advantages are many and they are still further increased by making the figure a triangle. I therefore adopted the one in which the base of the triangle is exactly equal to the height, which is the most convenient form for the reduction of the results, and has, as you will at once see, this property,— that the difference in time of transit between two bodies crossing it, converted into arc, is their difference in declination. Of course, if the observations are made away from the equator the difference must be multiplied by the cosine of the star's declination; and since the determination of this distance depends upon the observation of time in a triangle so proportioned that the differences in time are equal to those in declination, the declinations are as valuable as the right ascensions, which as we have seen is not the case in the ring micrometer. In use the triangle is very convenient: by allowing a star to run along the base while the instrument is at rest it can at once be set in position, so that its base is a parallel of declination and its perpendicular one of right ascension.

If the transits are observed at ingress and egress for each side, four transits are obtained from which to get the mean.

The sides of the triangle may be tested by allowing a star to run along, which if they are not straight will at once show the irregularity.

In the absence of a wire micrometer it might be of some service in estimating angles of position and distance; for the times of transit may be made to indicate the distance, and the lines of the triangle supply six known angles of position, as shown in diagram herewith.



When the line O.M. is adjusted by the passage of a star, the sides are in the following angles of position :—

M	to	A	Angle of	position	...	26° 34′
O	to	M	„	„	...	90° 0′
O	to	B	„	„	...	153° 26′
M	to	B	„	„	...	206° 34′
M	to	O	„	„	...	270° 0′
O	to	C	„	„	...	333° 26′

Before concluding I would like to draw your attention to a change in Saturn's belts since last year: there are two dark bands at about 45° declination, one on either side of the equator.

Notes on Jupiter during his Opposition, 1878.

By G. D. Hirst.

[*Read before the Astronomical Section, 6 September, 1878.*]

I have the pleasure of laying before you a few sketches of Jupiter, made this opposition.

At the planet's approach in 1876 I was able to secure a number of drawings, which I had the honor of exhibiting to the Society at the August meeting of that year; they were afterwards forwarded to Dr. Lohse, at Potsdam. In his letter acknowledging the receipt of these, he expressed a hope that the oppositions of the succeeding two or three years would not be allowed to pass by southern observers without securing a permanent record of the planet's appearance. Last year, however, whether it was that the extremely favourable opposition of Mars absorbed all our attention, to the exclusion of Jupiter, I cannot say, but I have since heard that Dr. Lohse has expressed regret at the few drawings of Jupiter which reached his hands for that year.

As the planet is still more unfavourably placed for observation in Europe this year, by reason of his increased southern declination, the doctor has again appealed to us not to let the opposition of this year pass unrecorded.

The drawings I have to exhibit are but few, as unfavourable weather early in the opposition, and other demands upon my time, have prevented me from making any regular observations; still, as far as they go, they may be considered typical of the most prominent and permanent features of the planet as fairly as I can represent them at the present time. They have been drawn principally from the Merz 7¼-in. refractor at the Sydney Observatory, for the use of which I am indebted to the kindness of our Chairman. Three are from the telescope I used in 1876, viz., Mr. Colyer's 10¼-in. reflector.

Speaking of these telescopes, there is one peculiarity which has struck my attention this year. You will perhaps remember that my notes in 1876 mention the strange discrepancy in the colour of the equatorial belt shown in the refractor and reflector.

In that year the colour of the broad equatorial band in the silvered glass reflector was a rich tawny orange; you will see the colour in this diagram, which I exhibited to the Society in 1876, as a sort of *résumé* of the most prominent features of the planet. This band at that time appeared in both of the observatory refractors of a bright pink; the discrepancy was confirmed by Mr. Russell, who examined the planet with a silvered glass mirror of his own make. Now if you will compare the drawings before you, made from the reflector, with those from the refractor, you will see that

this difference has vanished; the northern equatorial belt appears in both descriptions of telescope of a bright coppery red, and the southern half ochre-yellow, inclining sometimes to grey.

There is something at present unaccountable here; for if the diversity of tint exhibited by the reflector and refractor two years since appeared inexplicable, their agreement this year makes matters still more strange. It would be interesting at future oppositions to make similar comparisons, which might eventually throw some light on the subject.

Referring again to the large diagram, and comparing it with the drawings of this year, we notice at once the alteration undergone by the equatorial belt; in 1876 it invariably presented itself as a broad band traversed in several places by narrow dark streaks; last year what was before the central portion of this band, was the brightest part of the planet's disk, the broad band had split into two belts. This appearance is still preserved, the northern band being, as I said, bright copper colour, and the southern one ochre, or sometimes grey.

In 1876 the changes in the equatorial zone appeared to be very sudden and violent, the lower portion of the belt could rarely be recognized after one or two revolutions. This year it appears to be much more quiescent, the changes that occur are slower, and the same portion of the belt presents generally but little alteration after the lapse of several days. One bright red spot, referred to by Mr. Russell in the *Herald*, now more than a month ago, still appears in the same place, having undergone no alteration of shape or position; it corresponds very much to a marking we called the "Fish" in 1876, being on the same, viz., the south side of the equatorial belt, the only difference being that in that year it was incorporated in the belt, from which it is at present well detached; its shape is exactly the same, though it is now reversed, the preceding end tapering off, instead of the following.

The north pole of the planet, in 1876, appeared in the reflector in nights of good definition, of a fine sea green tint. I have looked for this colour this year in the refractor, but have not been able to see it; the northern shading has always appeared light brown, and on one or two occasions grey.

Definition on the night of the 31st August was superb, and observing Jupiter in the reflector, I again noticed the green tint; to be well seen it seems to require most perfect definition, a large aperture, and perhaps the almost absolute achromatism of the silvered glass reflector is also a great requisite. Between the north polar shading and the equatorial band there is a narrow streak, which probably extends quite round the planet, for it has been visible on every occasion. I have suspected a purple tint on this once or

twice when using the refractor; on the evening of the 31st August the reflector showed it to be without doubt of a rich dark purple.

I have not observed any of the small white spots that have been remarked at previous oppositions, nor any of the minute and intensely black ones which I saw so repeatedly in 1876; larger and ill-defined spots of a very dusky hue have been seen on the equatorial band this year, but they are evidently not of the same character.

On the evening of the 24th August there was a transit of No. IV satellite. I did not see the ingress, but at about 9·45 p.m. I looked at the planet with a 4¾-in. refractor belonging to Mr. A. Fairfax, and was immediately struck with what appeared to be an intensely black spot on the northern portion of the equatorial belt. It was quite as black as the shadows of any of the satellites in transit, and for this I at first mistook it, until upon reflection I could not see any satellite in a position to cast the shadow. It grew lighter as it approached the limb, and finally at the edge became quite bright. I have since noticed No. IV, as compared with the other satellites on the dark background of the sky; it is certainly much less luminous, and if they were stars I should say it was two-thirds of a magnitude smaller. It must certainly possess reflecting powers vastly inferior to any of the others, to become so intensely black by contrast with Jupiter's disc. I could understand its appearing dusky under the circumstances, but it is difficult not to imagine that there is not some other cause for such intense and pitchy blackness.

In conclusion, I would express a hope that the anticipations of Dr. Lohse and others working with him, of a gain to our knowlege of the physical conditions of Jupiter derived from a connected series of observations may not prove vain. One cannot help sometimes, as I have once before said, putting the question whether we are not after all but drawing "clouds on the summer sky;" yet now and then, as if to encourage us, we see markings possessing a certain permanence which might lead us to suppose that all is not vapour, and if the result of many years' watching should be the establishment of cycle of changes on the surface of our "giant planet," a great step will be gained, and our labour well repaid.

On Star-discs and the separating power of Telescopes.

By W. J. MacDonnell, F.R.A.S.

[Read before the Astronomical Section, 4 October, 1878.]

The fixed stars, although many of them are suns rivalling and often exceeding ours in splendour and magnitude, yet, owing to the enormous distances which separate them from our tiny world, appear as mere points of light, no telescope, however large, no magnifying power however great, has ever raised a real disc like that of the planets. It is, nevertheless, a well known consequence of optical laws, explainable by the undulatory theory of light, that the telescope shows the stars with a sensible disc of a varying size according to the nature, quality, and power of the instrument used; and it is a question of great practical and important interest to the double star observer to ascertain the conditions which govern the size of these false or spurious discs as they are called. Are the spurious discs dependent on the aperture or focus or the relation of aperture to focus; and with the view of raising a discussion on this question, I have brought together some of the views of a few of our leading observers on this subject.

Sir G. B. Airy, Astronomer Royal for England, in his "Undulatory Theory of Optics," p. 80, has shown that the image of a star in a telescope is a circular disc rapidly decreasing in brightness towards the margin and degrading to a ring of absolute blackness, surrounded by a series of alternate bright and dark rings, the intensities of the bright rings being respectively about $\frac{1}{57}$, $\frac{1}{240}$, $\frac{1}{620}$ of that of the central disc. Two well known practical observers in England have given this subject a good deal of attention: one, the late Rev. W. R. Dawes, and the other, Mr. G. Knott, of Cuckfield. Mr. Dawes had experimented with telescopes by eight different opticians, and came to the conclusion that the size of the star discs depended on the aperture only, irrespective of focal length, and found that the diameter of the star images varied inversely as aperture, and taking one inch aperture as a standard, ascertained that with this he could separate stars of the sixth magnitude $4''\cdot6$ apart, and hence the separating power of any given aperture "a" will be expressed by the fraction $\frac{4''56}{a}$—(Monthly Notices, Vol. 27, pp. 217–238. See also "Astronomical Register," vol. 3, p. 153, and vol. 5, p. 100; "Intellectual Observer," vol. 8, pp. 240 and 276; Smyth's "Cycle," vol. 1, p. 417).

Mr. G. Knott, who is an experienced observer, and is the possessor of a fine $7\frac{1}{3}$-inch Alvan Clark refractor, instituted a series of experiments for the direct measurement of the telescopic discs of stars, employing various apertures of his telescope for

comparison. He found a marked and pretty regular increase in the apparent diameter of the disc as the aperture of the telescope is diminished, thus agreeing with the results derived *a fortiori* from theory. For example, the measurements of α Lyræ (Vega) were—

Aperture 7 in·33—6 in·0—4 in·95 4 in·00—3 in·00—2 in·00
Size of disc 0″·731—0″·907—0″·991—1″·284—1″·829—2″·435

("Monthly Notices," vol. 27, pp. 87 and 88.) In a letter to the "Astronomical Register," vol. 5, p. 51, Mr. Knott further states that, other things being equal, the separating power of a telescope depends solely on its aperture, the diameter of the disc and rings varying inversely as the aperture; in other words, the larger the diameter of the object glass the smaller is that of the apparent image of the star.

The eminent optician Dallmeyer agrees closely with Mr. Dawes in the separating power of telescopes, which he finds to be $\frac{4''\cdot33}{\text{for 1 inch.}}$

On the other hand, Mr. Warren de la Rue thinks that focal length has something to do with the size of the discs ("Astronomical Register," vol. 5, p. 128).

Steinheil, the well known German optician, is of opinion ("Astronomische Nachrichten" No. 1525—"Intellectual Observer," vol. 7, p. 480) that it is a known consequence of the diffraction of light that the stars appear as discs with measurable diameters. These diameters stand in relation to the intensity of the light, and the proportion that exists between the aperture of an object glass and its focal length, so that a telescope of 8 inches aperture and 12 feet focal length, which could not divide γ^2 Andromedæ, would necessarily give to the component stars larger discs than one of the same aperture and shorter focal length.

Mr. Dawes controverted this opinion, and Steinheil partly accepted his correction, and explained the fact that his 8-inch telescope did not separate stars which other instruments of the same size will divide by ascribing it to the superior light of his own instrument. By augmenting the apparent brightness of a star, he said, its disc was increased and diminished by lessening its brilliancy. It has been long known that a central patch to stop out the middle rays has reduced the brilliancy of the stars and their discs, and thus increased the separating power of a telescope; hence the superiority of a reflector, the small reflector acting as a stop to the central rays. ("Intellectual Observer," vol. 8, p. 240.)

It will be seen from the foregoing extracts that the balance of opinion is that the separating power is principally a function of aperture only, but we have in Sydney refractors up to 11⅓ inches, and reflectors to 10¼ inches apertures, and experiments could be instituted by members of the Section to throw further light on this interesting question.

Abstract of the Results of Transit of Venus.

By H. C. Russell, B.A., F.R.A.S., Observatory.

[*Read before the Astronomical Section, 4 October, 1878.*]

I thought that it would be interesting to the members of the Astronomical Section, if a short abstract of the results of the Transit of Venus observations as published by Captain Tupman in the June number of the Royal Astronomical Society's Notices were made. It would be impossible without destroying the value of it to make an abstract of the whole paper; it was prepared to show how the various observations used in determining the parallax have been combined, and it is as short as possible, but we may extract just such portions as indicate the value of the work done in this colony.

It will be within your recollection that the preparations for this grand astronomical event, the Transit of Venus, in 1874, enlisted the efforts of the astronomers in every country in the world, and in most cases Governments took an active interest in the work. Captain Tupman discusses only those observations made by the British nation, and from all the preparations and parties sent out to observe it, in Egypt, South Seas, New Zealand, India, and Australia, there were only thirty-one observers whose reports could be made available for the determination of the sun's parallax by observation at *ingress*; of these, eight are from the New South Wales parties, and five from the Victorian parties. But by a system of giving weights, and rejecting observations thought doubtful, the number used in determining the parallax was reduced to twenty; of these, eight receive double weight, and again our observations take a favourable position; there are three New South Wales observers, and two, Messrs. Scott and Russell, receive double weight, and MacDonnell single weight; while there are three observers in Victoria, and only one gets double weight; so that for parallax at ingress the Observatories at Sydney and Melbourne furnish six out of the twenty reports from the whole British nation.

For the observations at egress there was a larger number of available reports. The experience at ingress had in fact, as some of us remember, taught us to record what we did see, and not look for what we could not see. There are forty-eight observations of egress, and again New South Wales furnishes eight, and Victoria four, and when the observations are weighted, seven of the forty-eight are struck out as no use, but all ours remain, and two of them again, Vessey and Russell, with double weight, and the other six, Allerding, Hixson (Capt.), Lenehan, Liversidge, Wright (Dr.), and Tornaghi, get the usual single weight; of the

four Victorian observers, only one gets double weight, and Adelaide, with four observers, two are struck out by the weighting, and one gets double weight. So that Australia, if we include Mr. Tebbutt's observations, furnishes seven out of the twenty available reports at ingress, and fifteen out of forty-one at egress; in both cases more than one-third, and this is no small honor for Australia: one-third of the observations obtained by the whole British nation.

The resulting mean solar parallax at ingress is 8″·845, and by those at egress 8″·846, or a mean of 8·8455, equal a distance of 92,400,000.

Captain Tupman remarks that the observations at Sydney by Russell, Lenehan, Wright, and Allerding have great weight in lowering the parallax or increasing the sun's distance; but he sees "no reason for rejecting them, on the contrary he has given double weight to Russell, and his is one of the most detailed observations made"; and Dr. Wright's and Mr. Russell's agree exactly; Mr. Lenehan is only 3s., and Mr. Allerding 5s. from the two first. It is obvious that four such observations could not be rejected, and although they have had much to do with making the sun's distance half a million of miles greater, they have been retained. But this fact really opens up a most important question, viz., how far that distance in such observations is affected by atmospheric conditions? It is well known that, at the moment of egress, the atmosphere at Sydney was wonderfully steady, and all four observers are by the general testimony of all other observers made to be late in their recorded time; now this I think simply means that they were able, owing to the splendid definition, to see the line of light for a few seconds longer than those who observed through a less favourable atmosphere.

I need scarcely recall the circumstances of the transit; Venus, as a black disc moved over the sun's bright surface so slowly that the motion could only be seen when it was near the sun's limb, and a second of arc was only passed over in about ten seconds of time; now a second of arc is far less than the displacement which an ordinary atmospheric tremor would produce, so that the limbs of Venus and the sun would be seen in contact under such unfavourable circumstances from 10 seconds to 20 seconds before they would so appear to an observer in the perfectly steady atmosphere which existed at Sydney at the time; and it is quite in accordance with what might have been expected that we should make the egress late when compared with others observing in an unsteady atmosphere. It seems, therefore, that the correct way of dealing with the observations in which some were early and others late from uncertain atmospheric conditions, is that which has been adopted, namely, taking a mean of all the results; including the late and early ones, and it is noteworthy that for egress in

New South Wales the average of all the observations is 8·6 seconds late; and it is a fact that here we were all favoured with exceptionally fine and favourable weather.

It is to be regretted that the photographic observations have not yielded better results. The use of photography was urged as an experiment by many astronomers in Europe, and the wisdom which induced the British observers generally to combine it with other means of observation as a means of filling up the time between ingress and egress, when little else could be done, is now apparent. Some money and labour were spent upon it, but here, at least, the method was not allowed to interfere with eye observations; and if the photographs have not helped to determine the sun's distance, they have at least taught us something, and revealed some remarkable physical features of Venus, which, had it not been for the unbiased testimony of photography, would have been set down as optical illusions experienced by the few observers who saw them; but the testimony of the photographs to the ring of light round Venus cannot be disputed; nor can the testimony that the ring of light was more brilliant than the sun itself be any more disputed, for the photographs show that it deposited more silver than the sunlight. I will not detain you to point out many other important results of the photographs; no one can justly regret that the time was devoted to them, for compared with the labour, they yielded more than the usual increment to increased knowledge; but it certainly is to be regretted that they did not turn out all that scientific men wished them to be, for then we should have known the solar parallax within a mile.

Note on the Geocentric Conjunction of Mars and Saturn, on July 1, 1879.

By John Tebbutt, F.R.A.S.

[Read before the Astronomical Section, 1 November, 1878.]

As the present meeting of the Astronomical Section of the Royal Society is the last of the series for the current session and the members do not again meet till the middle of next year, I think it will be desirable to draw their attention to the remarkable circumstances connected with the next conjunction of the planets Mars and Saturn. I find from an approximate calculation for the centre of the earth, that the conjunction in right ascension will take place at 5h. 50m. in the morning of July 1, 1879, mean time at Sydney, but that the nearest approach of centres will occur nineteen minutes previously, being seventy-one seconds of arc. The distance as seen from Sydney will be slightly greater than this, owing to parallax. The phenomenon will be invisible to Europe and America, but it may be well seen from this part of the earth. To observers without telescopes the planets will at the time indicated appear to be but one object, and, doubtless, in the ages when astronomical observers were unprovided with telescopes the phenomenon would be set down as an occultation of Saturn by Mars. Within the past quarter of a century at least there is no instance of the two planets approaching so near to each other in their geocentric tracks, and I believe that during the same period there are only three instances in which any two of the old planets came into the same aspect. The distance between Jupiter and Venus was about a minute of arc on July 20, 1859. Mercury approached Venus and Jupiter within about the same distance on December 5, 1859, and April 24, 1869, respectively; but these phenomena were unfavorably situated for observation.

Some Remarks on the Mounting of large Object-glasses.

By H. C. Russell, B.A., F.R.A.S.

[*Read before the Astronomical Society, on 1 November, 1878.*]

It is perhaps hardly necessary to remark here, that although the first-class optician aims at *perfection*, and comes nearer to it perhaps than any other artist,—although he can, by the aid of Fraunhofer's beautiful method of testing the refractive indices of different pieces of glass, and mathematical formula all ready to his hand, determine exactly what curves his lenses should have in order to effect his purpose,—yet the *exact* accomplishment of these curves in each case is a matter of chance; he can be sure of getting very near what he wants, but to be exact is more than human. His only resource, therefore, is by trial to make the best of the lenses he has made, and his patience is, I believe, generally rewarded by the best result under the circumstances. When *he* has placed and marked the glasses, as a rule it is folly to attempt improvement; yet there are exceptions in my own experience of so much practical importance that I have ventured to say a few words about them this evening.

Some years since 1861 the Observatory received from Messrs. Merz and Sons, of Munich, a 7¼-inch refractor, which appeared to be in every respect a first-class instrument. In 1870 I began to use this instrument for double star measures, and was by no means satisfied with its performance; for instance, I could not see the companion to Antares, for the false light and want of definition that enveloped the large star. Reasoning about this, I was led to the conclusion that perhaps it would be possible to make a better adjustment of the lenses than the maker had done, and after many attempts, I found the definition wonderfully improved by separating the lenses by three pieces of tin 0·087in. thick in addition to the three pieces put in by the maker, and which measure 0·008 in., so that the lenses are now separated by 0·095 in., and the focus is shortened about two inches, the original focal length being 10 feet 4 inches. The companion of Antares is now quite an easy object, and the definition, under favourable conditions of atmosphere, leaves nothing to be desired, and a power of 800 has been used with advantage.

Such experiments are troublesome, and not without risk, still it is worth while to make the experiment when mounting large lenses.

It is almost the invariable custom of opticians to support large lenses on three points only, and in the 7¼ inch Mertz I could never detect any flexure from this cause, although the glass is not very thick.

When I received the 11½-inch Schroeder telescope I had not forgotten the experience with Merz, and I tried separating the lenses

as before, but each thousandth of an inch that the lenses were separated made the definition worse. In this case the curve of the second surface has a smaller radius than the third, so that the lenses put together without foil touch in the centre, and the maker sent them out with pieces of foil just thick enough to support the edges, and at the same time let the lenses touch in the centre, and a beautiful batch of Newton's rings marked the point of contact.

These lenses, as usual, were supported only on three points, but in this case I found that with full aperture and high powers there was a decided tendency to a triangular figure in the rays about bright stars; I therefore removed the three points in the brass cell on which the lenses rested, and allowed them to rest directly on a plain brass ring touching all round, and I put three more pieces of foil between those placed by the maker, so that the lenses were supported on six points inside, and on the brass rings outside; this nearly cured the triangular figures, and I determined to put a piece of paper in the form of a ring so as to support the lenses all round. Now several difficulties arose here: this ring of paper was to be $11\frac{1}{2}$ inches in diameter, and $\frac{1}{16}$th of an inch broad, and more important still, exactly 0·010 inch thick; the nearest to this I could get was 0·012 inch, and when it was in I knew the lenses were 0·002 inch separated in the middle, and therefore not in the best position for work. The paper, when wet with gum, was not a convenient thing to place, and in some parts it extended farther from the edge than was desirable. I removed it and tried to replace it with foil exactly 0·010 inch thick, and here a fact became evident that has had a great deal to do with my writing of these remarks. The thickness of foil which I wanted was 0·010 inch; the nearest I could command was 0·0105 inch, and this was put in and the lenses did not touch in the centre. The next thinner foil measured 0·009 inch, and I tried this; now the lenses not only touched in the centre, but one would spin freely on the other as if it did not touch the foil at all; I was obliged therefore to use 0·0105 inch, and twelve pieces of this were carefully placed round the edge of the lower lens, and then the upper one put on it—no rings appeared, and I put my finger on the centre and pressed hard to see if I could produce them, but without effect. You will observe that the difference in thicknesses of tin foil on the two experiments is only 0·0015 inch, yet in one case the lenses touch in the middle and will spin as if not resting on the foil at all, and in the other case they do not touch, nor will they together; for the lower lens was only supported in the centre, bend under considerable pressure 0·0015 inch. This result surprised me a good deal, for I feel certain that the actual distance between these lenses as now mounted cannot be more than 0·0005 inch, and yet the two lenses, when pressed in their centres, will not together bend that small quantity.

On a new form of Equatorial Mounting.

By H. C. Russell, B.A., F.R.A.S.

[Read before the Astronomical Section, 1 November, 1878.]

The question—How shall a telescope be mounted? is one that has not, in any of the answers which have been made, received its final answer; and yet it is one of such great importance to the observer, that one can readily understand the number of mountings which have been suggested. In fact, it comes to this: that each form has some advantages over the others, and it must be left to each observer to select what may suit and, at the same time, please him best. In regard, however, to large mounting, or rather the mounting of large telescopes, the conditions are somewhat different from those affecting smaller instruments, and so few have have been mounted that the results of experience are meagre. There can be no doubt that the form used by Mr. Grubb in mounting the great Melbourne reflector, and which has in principle been repeated in mounting the great reflector at the Paris Observatory, is thoroughly effective, and enables the observer to point his telescope to any point in the heavens; but the quantity of metal necessary to make such a form rigid is enormous. First the telescope must be fixed to the end of the equatorial axis, and in order that no flexure may take place, the tube must be made rigid enough to support its own weight as well as that of the speculum, when all are hanging on that one point when it is attached to the axis. This, of course, involves a great increase of weight about the tube, and a corresponding weight must be put on the other end of the equatorial axis. Mr. Lassell, to avoid this, continued the polar axis beyond its upper bearing, and forked it so that the telescope worked freely between the sides of the fork; but, although all unnecessary weight in the tube, as well as counterpoise, are by this plan avoided, we have another equally objectionable condition introduced, and that is the extreme distance from the point of support at which the telescope is hung. Now it has occurred to me that a modification of the equatorial mounting is possible, which avoids both these difficulties, by sacrificing a small part of the *range of the telescope;* and as it is only proposed for large reflectors the sacrifice of the ability to see objects on the horizon is of little or no consequence, for such an instrument is worse than useless for observing objects far from the zenith. Much more can be seen there with a refractor of very moderate dimensions, and this appears to me sufficient reason for the proposed curtailment of range, without considering the serious effect the horizontal position has on the adjustment of the large mirror, so serious, indeed, as in most cases to oblige the observer to readjust the instrument.

The plan proposed then is, to make a polar axis, the lower end of which is similar to that in an ordinary equatorial stand, but from that point upwards it branches into two arms, wide enough apart to allow the telescope room to move between them. On these arms the telescope is supported, like a transit instrument, on its centre of gravity, so that no counterpoise is required; and the tube being supported at two points need not be made so strong as in the ordinary mounting. Now so far as we have Mr. Lassel's plan; but my proposed alteration takes the two sides of the polar axis beyond the point at which the telescope is supported, about one-third of their length, and there unites them into a very rigid semi-circular piece, which is very carefully turned, and runs on two large friction wheels; this, in fact, constitutes the second bearing of the polar axis. With proper care, such a bearing may be made sufficiently accurate for the purpose—I think as accurate as the ordinary bearing, and it would work quite as freely. A small piece projecting from the stand over the inner part of the semi-circle, and two small stops, prevent the polar axis from being turned too far, or thrown off its bearing.

Now the axis of the tube (declination axis) is made to bisect the polar axis, and the telescope may therefore be laid down in the semi-circular bearing, until it points to the pole, or it may be pointed to any degree of declination between that and 20° north declination, and in right ascension it may be moved at least six hours on either side of the meridian. The range, therefore, amounts to this: all stars, and all members of the solar system, from 20° north to 20° south may be watched from rising to setting, and all objects from 20° south to the pole may be watched from (say) seven hours before meridian to seven hours after it; and this is far more than such an instrument is wanted to do. A slight increase in the length of the polar axis would make the range greater, but that seems unnecessary.

Now as to the weight of the polar axis. Having much less to carry than the ordinary polar axis, and, from the method of support, all its own weight and that of the tube being brought within the bearings, it may be made light without fear of vibration. Another advantage, or rather several, will be found in the fact that there is less work in its construction, less metal to pay for, less trouble in putting it together, less room required in the observatory, greater facility of transport, and greater ease in working.

But about these I will not detain you. One word about the adjustments. At first sight they seem hopeless—the ordinary rules *won't* apply here; but there are others very simple and satisfactory which make the adjustment of this form perhaps less trouble than the ordinary equatorial stand.

To set the dec. vernier right, point the telescope to the pole, then turn the polar axis and adjust the telescope until it turns as a continuation of the polar axis, which may be known very nearly, by the tube turning from six hours before meridian to six hours after in its own diameter. To do this, put the telescope as directed, and the equatorial axis in the plane of the meridian, then bring an object to touch the side of the open end of the tube; turn the axis 180°; the other side of the tube should touch the same object; if not, move it until, on repeating the test, it will, then the telescope points to its own pole, and the vernier should read 90°.

Now, when this is adjusted, and the telescope tried on a star, and the observed declination does not agree with the tabular position, the polar axis must be raised or lowered until it does.*

Having now the polar axis at the true elevation, take meridian transits of two stars about equally distant from the equator north and south, the greater the declination the better. If clock error by each of these is the same, instrument is in meridian; if not, adjust it and repeat; or, set the telescope to the declination of a star (well known) and about six hours from meridian correct for refraction. If star is on declination wire, instrument is on meridian, if not adjust.

When in meridian, adjust hour circle vernier to read 0h. when a star is on meridian by clock.

Maker must set the declination axis at right angles to the polar axis.

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* Should there be a doubt about the polar and equatorial axes bisecting each other, this may be tested by applying the method above given to both ends of the tube at the same time; for if there was this error in construction, it would be impossible to get both ends of the tube to turn 180° in a diameter.

SECTION B.—CHEMISTRY, MINERALOGY, and by amalgamation with Section C, GEOLOGY and PALÆONTOLOGY.

The first meeting of the session was held on 12th April, when Dr. Leibius was elected Chairman, Mr. Dixon, Hon. Secretary, and Messrs. Bensusan, Sleep, M'Cutcheon, and Gipps, members of Committee, and the meetings for ensuing session were fixed for the third Wednesday of each month.

WEDNESDAY, 22 MAY, 1878.

Dr. Leibius in the Chair.

Dr. Leibius exhibited: (1) Some very nice specimens of bismuth-gold, from the Cloncurry, North Queensland, about 500 miles from Townsville. A large sample of this ore, weighing over 60 ounces, was, a short time ago, imported into the Mint, and found to consist of about 10 per cent. coarse nuggetty gold (assaying 98 per cent. fine gold) and earthy matter, with little quartz, containing a large quantity of carbonate of bismuth. Very fine gold was largely disseminated throughout the whole sample, which yields over 21 per cent. of pure gold. It is stated that bismuth exists in large quantities in the above-mentioned locality. (2) A specimen, consisting of conglomerate of crystals of carbonate of lime, richly interspersed with gold; also, (3), small specimen of quartz, almost covered with gold. Both the last two specimens came from a place about 18 miles distant from Ravenswood, Queensland, from a depth of 100 feet. They were presented to the Mint by Mr. C. Hansen, and exhibited by the kind permission of the Deputy Master.

Mr. Dixon showed a piece of glass having a curious exfoliation on its surface. The glass was a circular piece cut from a crown glass flask, which had been used as a wash bottle, and in which water had been frequently boiled during eighteen months. On placing the piece on a hot plate, the temperature of which was probably between 300 and 400 degrees F., the interior surface developed numerous radial cracks, between many of which a film of glass separated and curled up, covering the surface with a multitude of spiculæ, some of which were 0·2 inch in length. They were rather less than 0·01 inch in thickness, and were quite transparent, but it seemed as if the long continued action of boiling water had altered the glass to that depth by removing some of the alkali, and that the portion so altered separated from the remainder under the circumstances described.

Messrs. Bensusan and Sleep were appointed Curators of the Mineral Cabinet.

WEDNESDAY, 19 JUNE, 1878.

Lapsed from want of a quorum.

WEDNESDAY, 17 JULY, 1878.

Dr. LEIBIUS in the Chair.

The CHAIRMAN laid on the table a letter from Mr. Gipps, M.E., inviting the members of the Section to visit Mount Prospect and inspect the geological formation of the district.

Mr. DIXON exhibited a specimen of rich silver ore submitted to him for examination by the Department of Mines. The sample contained sulphides and metal, 10·16%, and yielded, silver 522 ozs. 2 dwt. per ton, and gold, 18 ozs. 6 dwt. 10 gr. per ton. The sulphides consisted of iron pyrites with antimony, and traces of copper and lead. Also an ore from the border of Queensland, containing 7% copper, 19% lead, and 16 oz. 16 dwt. silver per ton.

Mr. M'CUTCHEON read details of ammonia determinations made at intervals of Sydney water as supplied to the Mint. He found:—

	Free ammonia. Parts per million.	Albumenoid ammonia. Parts per million.
1877.—September 7	0·014	0·15
10	0·016	0·15
October 5	0·010	0·16
25	0·010	0·13
30	0·010	0·18
November 2	0·014	0·19
1878.—February 16	Trace	0·16
21	,,	0·16
April 23	,,	0·18

These results show that the Sydney water is about on a par with the filtered Thames water supplied in London by the Southwark and Vauxhall Companies.

WEDNESDAY, 21 AUGUST, 1878.

Dr. LEIBIUS in the Chair.

The CHAIRMAN reported that he and several members of the Section had visited Mount Prospect on the invitation of Mr. Gipps, and laid on the table specimens of diorite, &c., which had been obtained.

Mr. BENSUSAN exhibited a specimen of silicate of copper (Chrysocolla) accompanied by native copper and red oxide, from Parkes.

WEDNESDAY, 18 SEPTEMBER, 1878.

Dr. LEIBIUS in the Chair.

Mr. DIXON brought under the notice of the meeting a process for making phosphorous acid. Having occasion to make some of the acid, he used the process by Schiff, by acting on phosphorus with sulphate of copper, but found the sulphuric acid set free in the reaction to be a cause of considerable trouble. He therefore tried whether oxide of copper would yield the acid by the equation

$$3\,CuO + 3\,H_2O + 5\,P = 2\,H_3PO_3 + 3\,CuP$$

and found that by adding phosphorus and oxide of copper in the proportions shown by the equation to water, the acid was readily produced. The phosphorus was granulated, and the mixture put in a stoppered bottle, when the solution soon became bluish green, and metallic copper was deposited. The solid matter set into a compact mass, which, with occasional shaking, gradually disintegrated, and in three weeks the solution became colourless, and consisted of a pure solution of phosphorous acid. The solid residue consisted of metallic copper mixed with one or more of the higher phosphides; but although the equation thus does not represent the actual reaction, it does so practically, as there remained no oxide of copper and mere traces of phosphorus.

Dr. LEIBIUS stated that some parcels of silver from near Tenterfield had been received at the Mint, and the metal was found to contain a considerable proportion of antimony.

WEDNESDAY, 16 OCTOBER, 1878.

Dr. LEIBIUS in the Chair.

Eighteen specimens of fossil leaves from Tertiary beds at Dalton, which had been sent by John K. Hume, Esq., were exhibited.

Mr. BENSUSAN laid on the table a specimen of indurated clay from the boring at Newington, from a depth of 1,150 feet, showing a nodule of quartz containing metallic copper, which had been cut through by the diamond borer. The clay is similar to that found at Bulli, 700 feet above the coal seam; also, a piece of black shale, from a depth of 1,100 feet, in the same boring, and a sample of graphite, from near Grafton.

WEDNESDAY, 20 NOVEMBER, 1878.

Mr. BENSUSAN said he had received from Mr. Sleep, for the mineral cabinet, some fine specimens of copper ores from Cloncurry.

Mr. DIXON exhibited silver ores from Boorook, and read a paper on the same.

Note on the Boorook Silver Ore.

By W. A. Dixon, F.C.S., F.I.C., Lecturer on Chemistry, Sydney School of Arts.

[*Read before the Chemical Section, 20 November, 1878.*]

As a new mining industry which promises to be soon of considerable importance has during the last few months begun to be developed in the Colony, I have thought it might be of some interest to lay before you a short *résumé* of what has been done at the Boorook silver lodes. I have had a considerable number of samples of the ores from the different reefs, &c., submitted to me for examination by the Mining Department, and can therefore show some specimens with assays.

Boorook is situated on the eastern fall of the Main Dividing Range, at a distance of about twenty miles in a north-east direction from Tenterfield. The country is very mountainous, and its geological formation is sandstone, granite, and slate, the last of which is reported to contain marine fossils. The argentiferous reefs appear to be found near the junction of the slate and granite.

Some seven or eight years ago a reef named the "Nil Desperandum" was discovered and opened out as a gold mine, a shaft being sunk to some depth, and two tons of the picked stone sent to the Mint in Sydney for treatment. The first ton from near the surface yielded 60oz. of gold and 45oz. of silver, and the second from the 40ft. level yielded 150oz. of precious metals, the proportion of each being about the same as the first. On sinking further into the reef however, the stone became poorer, and as the discovery of the rich tin ore deposits was made at this time, the mine was abandoned for what promised to be a more lucrative undertaking.

On the Addison reef a shallow shaft had also been sunk, but nothing seems to have been done with it, and it was the appearance of the stuff removed from this shaft that induced the present lessees to proceed with the exploration and put up a small machine for its treatment. This reef runs into a steep hill which rises at an angle of 30° or 35°; and at about a hundred and fifty feet from the base an opening has been made, and the reef is there found to be six feet wide, with well defined walls. A hundred feet higher up another opening has been made, and the reef is there of the same width and character. Twenty-five chains north 1° west from this is the original shaft, where the reef is three feet wide and has a westerly dip.

The stone from this reef varies considerably in richness ; one picked specimen yielded

Silver	522oz.	2dwt.	0grs.	per ton.
Gold	18oz.	6dwt.	10grs.	„

and contained 10% of sulphides, &c. soluble in nitric acid. Other samples gave

Silver	1oz.	4dwt.	9grs.	per ton.
Gold	...	...	5grs.	„
Silver	20oz.	8dwt.	10grs.	per ton.
Gold	...	8dwt.	10grs.	„

and stone taken from the thirty feet level, gave

Silver	42oz.	10dwt.	0grs.	per ton.
Gold	...	10dwt.	19grs.	„

The mineral matter in the picked specimen contained iron pyrites, sulphide of silver, antimonite of silver, free silver and gold, and small quantities of galena.

The Golden Age reef appears to be a continuation of the Addison reef, as it is in the same direct line. A sample of the stone taken from the fifty feet level on the reef gave

Silver	98oz.	16dwt.	19grs.	per ton.
Gold	1oz.	4dwt.	0grs.	„

whilst a sample of the crushed stone from the same level as delivered from the stamper boxes of the machine, gave

Silver	83oz.	12dwt.	19grs.	per ton.
Gold	1oz.	0dwt.	0grs.	„

The whole neighbourhood appears to contain argentiferous reefs, and there have lately been discovered the Golden Crown reef, which runs parallel to the Addison, and distant from it about 10 chains. A sample of stone from the surface of this reef gave

Silver	459oz.	16dwt.	10grs.	per ton.
Gold	5oz.	11dwt.	14grs.	„

The silver in this ore is partly in the form of antimonide with arsenide, sulphide, and free silver.

The Cornstalk reef, situated about quarter of a mile east of the Nil Desperandum, and a mile and a half north from Boorook station, is two feet wide, and Curran's reef is in the same locality.

The Woolshed reef is three and a half miles north north-west from Boorook, and a sample of the stone yielded

Silver	5oz.	10dwt.	0grs.	per ton.
Gold	0oz.	0dwt.	19grs.	„

Near to this is the Alderman reef, a sample of which from the surface gave

Silver	37oz.	15dwt.	14grs.	per ton.
Gold	0oz.	9dwt.	5grs.	„

Another reef, the Copenhagen, contains a very considerable quantity of galena, a sample of the stone yielding

Lead	13·4%			
Silver	5oz.	16dwt.	48grs.	per ton.
Gold	0oz.	0dwt.	10grs.	„

The method adopted for the treatment of such of the ores as have been already washed is exceedingly crude, much of the silver being lost by the imperfection of the process. It seems probable indeed that most of the silver which has been hitherto obtained is that which is present in the ore in the free state, and that on further sinking on the reef when the water level is reached, and black unweathered ores only are obtained, the produce by the present method would be nil.

At present the stone after crushing is run over blankets, and the material saved on them is subjected to grinding with mercury in a Berdan pan, the tailings being run into pits, to be saved for subsequent treatment. The separation of the ore by the blankets, if the slime had also been saved, would have been pretty successful in the case of the first ores which I saw, but in recent specimens the silver is much more minutely disseminated through the quartz.

If the contents of the stone going through the battery is compared with the products, it will be seen that great loss is experienced ; thus, a sample of the crushed stuff gave

Silver	83oz.	12dwt.	19grs.	per ton.
Gold	1oz.	0dwt.	0grs.	„

Mr. Warden Graham reports that 5 or 6 tons of the stone is passed through the machine in twelve hours, and that about half-a-ton of this is saved on the blankets and yields 100oz. of silver.

Now 5 tons contain 418oz. of silver and 5oz. of gold, whilst the half-ton of tailings from the Berdan would contain by my assay 19oz. 0dwt. 17grs. of silver, and even if the whole of the tailings from the blankets had been saved, as these contained 10oz. 1dwt. 5grs. silver per ton, the loss of silver in the treatment of the five tons would be 252oz., even supposing all the silver in the residues was recovered.

This great loss is doubtless due to the exceeding friability of the silver ores,—the finest slimes, which take many hours to settle in still water, invariably containing more silver than the original ore. Phillips says of the Nevada ores that they yield 20% of slimes (not *tailings*), which from an ore containing 80oz. per ton contain 100oz. per ton of silver. I have myself found in one instance the slimes to be much more enriched, and that, when the mineral was carefully hand-crushed and dressed, but the quantity of the slimes produced was not more than 12% of the ore operated on.

In America the water holding these slimes in suspension is run into large settling ponds, three or four ounces of alum is added for each thousand gallons of liquid, and the whole is left at rest until the water is perfectly clear, the clarification being much hastened by the alum.

In the United States the richer silver ores containing over 80oz. per ton are ground dry, roasted with from five to ten per cent. of salt, and treated by amalgamation in barrels with scrap iron.

The poorer ores, especially in places where fuel is scarce, are treated by a direct method, based on the same principle as the patio process of Mexico, namely, that chloride of copper in presence of salt converts sulphide of silver into chloride. In Nevada, however, the process is hastened by artificial heat, and the reduction of the chloride of silver instead of being effected by mercury, is effected at the expense of the iron of the grinding pans. The process is carried out as follows:—The ore is broken and crushed under stampers, the whole material being saved, and 1,250 to 1,500lbs. of the sand is ground to an impalpable powder in a Wheeler pan, which takes about an hour. The contents of the pan are then heated to about 200°F. by steam, taking care not to allow the condensed water to dilute the mud to too great an extent, and 10 to 15% of the weight of the ore of mercury is showered into the pan by pressing it through a canvas bag. Two pounds of sulphate of copper and three pounds of salt or more are then added, and the grinding continued for three hours and a half, the temperature being kept between 180° and 200°F. Water is then added and the whole transferred to a wooden settling cistern, where it is kept in gentle motion until the mercury has settled. The pulp must only be so diluted that the mercury may fall to the bottom, and if the pulp appears thicker at the bottom of the settler than at the top, when the hand is plunged into it, with the stirrers making six or seven revolutions a minute, there has been too much water added. The separation takes about three hours, and when it is effected the sludge is washed away and the mercury filtered to obtain the amalgam, which is retorted. In this way from 65% to 80% of the silver is obtained, according to the ore operated on and care taken.

It seems highly probable that other discoveries of silver ores may be made in New South Wales. Such discoveries not having been made before is doubtless due to the fact that silver ores are not so readily recognizable as gold, and that prospectors have often little general mineralogical knowledge, in evidence of which we need only consider the comparatively recent discovery of the rich tin deposits lying almost on the surface. Many of the ores which have been worked for gold, notably about Mitchell's creek, contain much silver, and doubtless in treating for gold a great

quantity of this metal has been lost from the cause already stated.

It may be of some assistance to prospectors to note that silver deposits are generally found amongst the ancient stratified rocks, as micaceous, quartzose, and clay slates, limestone, and sandstone near granite. All the *great* silver deposits of the world, as at the Comstock in Nevada, Tracatecus, and others in Mexico, Carpathia, in Europe, and in Bolivia, are found accompanying a recent dioritic porphyry (the prophylite of Richthofen), probably of tertiary or post-tertiary age, though resembling ancient rocks. This rock is composed of a fine-grained basis, generally greenish, but sometimes red, grey, or brown, with embedded crystals of olioclase and dark green fibrous hornblende, whilst quartz is generally absent. The rock contains much iron and is decomposed by weathering, becoming stained red with the oxide.

The silver ore is generally found in quartz, and the surface of the veins is usually drusy and much stained with oxide of iron, whilst the quartz is often very friable.

SECTION D.—NATURAL HISTORY AND BOTANY.

[No report of the meetings of this Section has been sent in.]

SECTION E.—MICROSCOPICAL SCIENCE.

MONDAY, 1 APRIL, 1878.

The preliminary meeting of the session was held on the above date.

The Rev. George Martin was voted to the Chair.

The minutes of the previous meeting were read and confirmed.

The Secretary reported a donation of a number (45) of slides of hairs, from Professor Liversidge, previous to his departure for Europe.

The Secretary reported that he had received an answer to his letter, addressed to the General Council, requesting the use of the room during the recess; and in reply, they had stated that it was not considered desirable that the Section should meet during the recess.

On the motion of Mr. H. G. A. Wright, seconded by Mr. W. MacDonnell, the Rev. G. Martin was elected Chairman for the current year.

Mr. G. D. Hirst tendered his resignation of the office of Secretary to the Section.

The Chairman, on behalf of the meeting, expressed to Mr. Hirst their appreciation of the manner in which Mr. Hirst had discharged the duties of that office.

Moved by Mr. Hirst, seconded by Mr. W. MacDonnell, that Mr. Pedley be elected Secretary. Carried.

A ballot was then taken for the election of the Committee, and the following gentlemen were declared duly elected:—Dr. Morris, Mr. W. MacDonnell, Mr. H. G. A. Wright, Mr. G. D. Hirst.

It was decided that for the present session the meetings of the Section should be held on the evening of the second Monday in each month.

MONDAY, 13 MAY, 1878.

The Rev. George Martin in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. G. D. Hirst presented twelve miscellaneous slides to the Society's cabinet. Mr. Hirst also exhibited a Swift's portable microscope lamp, which, while perfectly adapted to the purpose for which it is intended, is of so portable a construction that it may be packed in a tin cylinder 7 inches long by $1\frac{1}{2}$ inch in diameter, and it possesses the further advantage that it may be carried in any position without leakage of the oil.

Mr. R. B. Read exhibited specimens of *Ophideres fullonica*, an insect which destroys large quantities of fruit, oranges in particular, by boring into the fruit and pumping out the juice. Mr. Read showed

a preparation of the *haustellium* (proboscis) of this insect, and also a series of drawings of the same magnified about 30 diameters.

The CHAIRMAN called the attention of the meeting to a box of polishing powder, sold under the title "Oriental Polish," which on examination proved to be a diatomacæous deposit of the purest character, fully 90 per cent. being the siliceous *loriceæ* of *diatomaceæ*.

Mr. PEDLEY exhibited the curious wheel-like plates which form the calcareous skeleton of the chirodota, from specimens found in Double Bay.

Dr. MORRIS showed sponge spicules and diatoms from Sydney water; and Mr. H. PATERSON, a preparation of the fumes of mercury.

Mr. W. MACDONNELL exhibited one of Seibert's 50th inch immersion lenses, and resolved some difficult tests with a Zeiss' 25th inch immersion lens, the microscope in this case being one of Swift's upon the improved Hartnach model.

MONDAY, 10 JUNE, 1878.

The Rev. GEORGE MARTIN in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. HIRST exhibited a reduced diagram of a photograph of British microscopic animals and plants collected from a pond at Leytonstone, near London. This exhibit, apart from its value as a representation of typical British pond life, possessed additional interest in that nearly every object figured had been identified in gatherings made in the immediate vicinity of Sydney.

Dr. CLUNE showed the alkaloid crystals of *Duboisia myopoides*; and Mr. H. Paterson some diatoms (*Eunotia diadem*) mounted by Dr. Morris.

MONDAY, 8 JULY, 1878.

The Rev. G. MARTIN in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. H. G. A. WRIGHT exhibited a Ross's new patent No. 2 microscope stand, on the Zentmayer principle. The stand embraces several valuable improvements, the principal of which are a movable tail-piece, carrying the substage and its accessory apparatus, which may be swung laterally either to the right or left. By this means any degree of obliquity of light may be obtained, the axis upon which it is worked being central with the object under examination. To such an extent can this motion be carried, that the mirror may be used as a condenser for the illumination of opaque objects, in place of the ordinary bull's-eye condenser. The stage is an interchangeable concentric rotating one, which can be almost instantly removed, and a thin diatom stage, or one more suited for dissecting purposes, placed in its stead.

Mr. Hirst recommended the placing of a piece of ground glass immediately beneath the achromatic condenser, by which means he obtains a soft pearly light, very suitable for the display of insect preparations, and with the least possible fatigue to the eyes.

Mr. W. MacDonnell, for Mr. H. J. Brown, exhibited and presented to the Society's cabinet a series of slides of spicules of *Synapta*, of small *Tunicata*, and of *Gorgonia*.

Mr. Martin showed Lord Osborne's diatom exhibitor, the object operated upon being *Gomphonema constricta, in situ* on *alga*.

Mr. MacDonnell exhibited some new and rare aulacodiscoidal diatoms from Peru and California, and Mr. Gilliat *Climacosphenia australis*.

Mr. Pedley exhibited a rich gathering of *Desmidiaceæ*, from Bondi; and Dr. Morris Möller's new series diatom typen platte.

MONDAY, 12 AUGUST, 1878.

The Rev. George Martin in the Chair.

The minutes of the previous meeting were read and confirmed.

Dr. Morris read a paper upon "The Incrustation of the Sydney Water-main."

Mr. Hirst exhibited some very thin glass suitable for the covering of micro-objects. This glass is simply blown from ordinary glass tubing, is incomparably thinner that the thinnest covering glass, and is so elastic that it is easier torn than broken, and may be readily cut to any shape with scissors.

Dr. Tucker exhibited a human fœtus six weeks old, and the hand and foot of another four months old.

Mr. F. B. Kyngdon exhibited a collection of insect preparations; and Mr. H. Paterson showed the partial crystallization of chalk subjected to a pressure of about 95lbs. to the square inch for three and a half hours, at a temperature of 350° Fahrenheit.

Mr. Martin exhibited Sertularian zoophites, and crystals of santonine, and Mr. Pedley, polyzoa from Port Jackson.

MONDAY, 9 SEPTEMBER, 1878.

Mr. H. G. A. Wright in the Chair.

The minutes of the previous meeting were read and confirmed.

The Secretary called the attention of the meeting to a handsome binocular microscope of Swift's make, which had just been imported by the Society for the use of the different Sections. The most noticeable feature of this microscope is a quarter-inch objective of 100° of angular aperture, specially adapted for use with Wenham's binocular arrangement.

There was little or no formal business to transact, but some interesting exhibits were made by the members present, amongst which may be mentioned a pocket microscope, adapted for medical

purposes, exhibited by Dr. Wright. This little instrument is as small as is consistent with practical utility; is fitted with a tripod stand, achromatic condenser, and two objectives, the whole packing in a case measuring but 4in. × 2½in.

Mr. G. D. Hirst exhibited a curious fungoid growth which had lately appeared upon a slip of pine wood that had been immersed for the last two years in a tightly stoppered vial of distilled water, and Mr. Pedley exhibited some slides of parasites and local polyzoa.

MONDAY, 16 OCTOBER, 1878.

The Rev. George Martin in the Chair.

The minutes of the previous meeting were read and confirmed.

Mr. W. MacDonnell exhibited a large and valuable series of micro-photographs of recent and fossil diatoms, executed by Dr. Gustav Fritsch, from specimens specially prepared by Herr Otto Müller. By means of an improved micro-photographic method, Dr. Fritsch has succeeded in producing a series of plates showing an amplification hitherto unattainable, owing to the great loss of light which has prevented the necessary enlargement.

Mr. MacDonnell read a paper describing the plates, and explained the bearing of micro-photography upon the question of the nature of the markings on the silicious skeletons of the diatomaceæ.

Mr. H. Sharp exhibited a beautifully stained section of tumour, Mr. Hewett slides of parasites, and Mr. Pedley sections of teeth.

Mr. F. B. Kyngdon presented for the use of the Section a postal cabinet for micro-slides.

MONDAY, 11 NOVEMBER, 1878.

The Rev. G. Martin in the Chair.

The minutes of the previous meeting were read and confirmed.

The Secretary, on behalf of Mr. H. Sharp (Adelong), presented to the Society's cabinet three beautifully mounted slides, comprising a stained section of cancer of the lip (*Epithelioma*); the scales of eight species of *Lepidoptera*, symmetrically arranged; and the gizzard of a large cockroach.

Mr. G. D. Hirst read some notes by Mr. Sharp upon a comparative trial of Powell and Leland's new formula 8th inch objective, with one of Zeiss' G. immersion lenses. Mr. W. MacDonnell exhibited the former lens, with which he resolved some difficult diatom tests.

Dr. Morris exhibited a pure gathering of *Actinocyclus Ralfsii*, from *fresh* water, Botany; Mr. De Lissa a collection of seeds and pollens; and Mr. Pedley sections of *Foraminifera*, from New Guinea, *Orbitolites*, *Alveolina*, &c.

Notes on the Incrustation of the Sydney Water-main.

By Dr. Morris.

[*Read before the Microscopical Section, 12 August, 1878.*]

About six weeks ago, one of the water-mains which supply this city with water burst, and having seen a notice in the papers that the inside of the pipe was encrusted an inch thick with a soft substance, I at once obtained a sample, but instead of being soft, I found that it consisted of layers of oxide of iron, with other ingredients. This deposit I now submit for your inspection. On boiling a portion of this deposit in muriatic acid, and afterwards in nitric acid, washing, and collecting the sediment, a microscopical examination of it proved that it contains a substance not accounted for in the following analysis, which was forwarded to the Mayor of Sydney by Mr. Charles Watt, and published in the *Sydney Morning Herald* of July 17th :—

Sir,—I have the honor to acknowledge the receipt of your communication of the 9th inst., and the packet containing a substance which had been found incrusting the 30-inch water-main leading from Botany to Sydney. The substance in question has had its origin partly from the oxidation of the mains and partly from suspended matters which have found their way with the water from the dams. By reference to the analysis it will be seen that this incrustration consists chiefly of oxides of iron, a large proportion of which is magnetic oxide. Magnetic oxide of iron has a well-marked action in promoting the oxidation of any organic matter which water may contain. In June, 1877, I reported to the Government respecting the composition of a deposit found in the street mains, and the incrustration now under consideration bears a very close resemblance to the article before mentioned. A microscopical examination did not show the existence of any forms of live animalculæ. I have the honor, &c.,

CHARLES WATT.

Analysis of substance forming an incrustation on the inner surface of certain water mains.—"Substance dried at 300° Fahrenheit before analysis. Oxides of iron (magnetic peroxide), 79·3; silica (chiefly in the form of sand), 4·5; volatile at red heat (consisting of combined water and organic matter), 15·1; alumina, ·5; traces of chloride of sodium, lime, loss, &c., 6·100·0."

I now submit for your examination a slide prepared from the sediment after treatment as above. This preparation consists of minute spheroidal bodies partly adhering to one another, accompanied by the silicious spiculæ which I once exhibited to you before. On carefully examining these spheroidal bodies, I came to the conclusion that they were composed of precipitated sulphur, and on applying heat a strong smell of sulphur was given off. The blow-pipe test gives the same reaction with the crude preparation. On seeing Mr. Watt's report to the Municipal Council, I put myself in communication with that gentleman, and on asking him what had become of the sulphur, he seemed quite incredulous about sulphur being a constituent of this deposit, as we had no sulphites in our water supply. However, on asking him to apply

the blow-pipe test, the fumes of sulphur soon became perceptible to his olfactory nerves. Since then he has made a second analysis, and returned it as containing 1½ per cent. of pure sulphur. This sulphur exists in this incrustration at the rate of 1½ per cent., or 1½ lb. to every 98½ of deposit in a free state. It can be dissolved out by bisulphuret of carbon, which shows that it is not chemically combined with the iron deposit. Now the question naturally arises, where does this sulphur come from? Mr. Watt, in a subsequent conversation with me, said he thought it must come from the iron piping. If so, what about arsenic and other kindred companions of sulphur found in the pyrites of the coal used for smelting purposes? Probably an analysis of the iron pipe would determine what are the ingredients besides iron, because if sulphur exists to such an extent in the piping, other deleterious ingredients are certain to accompany it. On the other hand, if the sulphur is a product of decomposed organic matter, then the sooner we have a new water supply the better, because this would admit that sewage to a great extent is still finding its way into our water supply. According to a report by the Commissioners appointed to inquire into the best means of preventing the pollution of rivers, they say,—"We now recommend therefore that with the exceptions already mentioned in reference to the standards D and E, the following liquids be deemed polluting, and inadmissible into any of them, viz., any liquid which contains in 100,000 parts by weight more than one part by weight of sulphur in the condition either of sulphuretted hydrogen or of a soluble sulphuret.

SECTION F.—GEOGRAPHY AND ETHNOLOGY.

[No meetings of this Section were held during 1878.]

SECTION G.—LITERATURE AND FINE ARTS, INCLUDING ARCHITECTURE.

This Section, which, from various causes, lapsed during the year 1877, was, through the exertions of a few gentlemen interested in the promotion and cultivation of the fine arts in this Colony, reorganized during the current session; and at a special meeting held 26 July, 1878, the following office-bearers were appointed:—Chairman:—Mr. E. L. MONTEFIORE. Hon. Secretary: Mr. PERCY E. WILLIAMS. Committee: Messrs. E. DU FAUR, LUDOVICO W. HART, G. A. MORELL, C.E., and Professor GURNEY, M.A.

It was decided that the future meetings of the Section should be held on the fourth Friday in each month, at 8 p.m.

On the motion of Mr. RUSSELL, seconded by Dr. LEIBIUS, it was resolved that the Council should be applied to, to subscribe to the *Art Journal*, *Portfolio*, and *L'Art*, from the 1st January, 1878.

Mr. LUDOVICO W. HART promised to read a paper entitled, "An Apology for the Introduction of Photography in our Schools of Art and Science."

The CHAIRMAN (Mr. E. L. MONTEFIORE) expressed his opinion that the Section would become one of the most popular with the members of the Royal Society, embracing as it did so wide a range of subjects, and trusted that the Colony at large would eventually profit by the united labours of the members of the Section.

FRIDAY, 23 AUGUST, 1878.

Mr. E. L. MONTEFIORE in the Chair.

It was notified by the Secretary that the Council had sanctioned the purchase of the *Portfolio*, *Art Journal*, and *L'Art*, from 1 January, 1878.

Mr. LUDOVICO W. HART read a most interesting paper, entitled, "An Apology for the Introduction of the Study of Photography in our Schools of Art and Science." The various reasons advanced pointed to the study and practice of photography as employments which would serve to enlarge the mind and refine the ideas, so that while we should be able to see and appreciate the wonders of nature immediately around us, we could as nations become more familiar with the various countries of the world, increasing our knowledge not only for our own benefit, but for the welfare of the whole human race. The paper concluded by expressing a

hope that the time was not far distant when we should see the commencement of a course of lectures on photography in connection with Schools of Art and Science, and the establishment of a training school for the purpose of giving a sound and practical knowledge of photography.

A lengthy discussion ensued as to the place photography took amongst the arts.

A number of valuable photographs and autotypes were exhibited; and a beautiful work on wedgewood, illustrated by photography, was laid on the table by Mr. E. L. Montefiore.

FRIDAY, 27 SEPTEMBER, 1878.

Mr. E. L. MONTEFIORE in the Chair.

Owing to the inclemency of the weather, only a few members were present, and Mr. J. W. STEPHENS, M.A., proposed to adjourn the business to the next monthly meeting (25 October), which was seconded by Mr. L. W. HART.

The Chairman exhibited some rare and curious specimens of sun pictures by Fox Talbot.

FRIDAY, 25 OCTOBER, 1878.

Mr. E. L. MONTEFIORE in the Chair.

Mr. LUDOVICO W. HART read a paper on "Photo-mechanical Processes," before a very large meeting, describing the processes of Woodburytype, photo-zincography, photo-lithography, photo-typography, photo-chromography, heliography, &c. Mr. Hart rendered his lecture greatly interesting by exhibiting a large number of pictorial specimens of the processes he described.

At the close of the reading an interesting discussion took place on the utility of the many processes and their inventors.

FRIDAY, 29 NOVEMBER, 1878.

Mr. E. L. MONTEFIORE in the Chair.

The last meeting of the session. A good meeting of members assembled to hear a very interesting and amusing paper on "Music," read by Mons. Jules Meilhan, who very ably set forth the claims of music as a fine art, and dwelt at some length on the desirability of classes being established for imparting a thorough knowledge to the rising generation. Until this was done we could not expect to hear high class music well rendered. Mons. Meilhan interspersed his lecture with several interesting anecdotes, illustrating the woes of composers and art critics in connection with stars and theatrical managers.

At the close of the reading, an animated discussion arose on the subject of the position of music in the Colony, many of the members echoing the desire of the lecturer, that a training school should be established.

At the close of the meeting, the CHAIRMAN thanked the members for their attendance during the session, evidencing the interest they took in the subjects appertaining to the Section. He trusted that during next session some of the members would be prepared to read papers upon literary as well as upon art subjects, to which the papers of the session just ended had been confined.

An Apology for the Introduction of the Study of Photography in our Schools of Art and Science.

By Mr. L. Hart.

[*Read before the Literature and Fine Art Section, 23 August, 1878.*]

Among the many splendid and important discoveries that have characterized the present century, few have more claims upon our sympathy than Photography. While many of these inventions have served only a special purpose, or benefited but certain communities, either industrial, artistic, or scientific, photography has placed its services at the disposal of all branches of human knowledge, and to use the words of Dr. Vogel, "There is scarcely a single field in the universe of visible phenomena where its productive influence is not felt." To botany, geology, astronomy, and geography, it is the faithful delineator of their marvels; in surgery, sociology, jurisprudence, its services are too well known to be dispensed with; in scientific research it has opened out a new field for the investigation of the philosophy of light; commerce and industry alike avail themselves of it, and to art and to art education it has become a handmaid and graceful satellite. It is as it were a new language, and may be said to be to "form" what printing is to "thought." To the photographer, the camera and its appurtenances are what the brush is to the painter, or the chisel to the sculptor. They are all causes of production, directed by inspiration of the mind, and guided by cultivation and intelligence. How rapid has been the progress of this new art-science. It has made its power felt throughout the length and breadth of the universe in less time perhaps than any other invention, and not only has it extended its application to various branches of art, science, and industry, in the dissecting room of the hospital, the astronomer's observatory, the philosopher's home, the editor's table, the artist's studio, public museums, and down in the profound depths of the earth, among miners; but it is in the humbler form of a portrait, where one of its greatest influences is felt. Here it makes no distinction as to whether it shall adorn castle or cottage, for in all the varied grades of fortune is it to be found. Its never-ceasing voice cries, "In memoriam, in memoriam." This single application of photography ought to be sufficient to secure our lasting gratitude. A portrait! What a boon of consolation it has been to thousands upon thousands of the human race, and what recollections does it not call up—a parent, sister, child, a dear friend, the native village in all its rural beauty, the old home wherein we were born. Scenes of home and childhood may be things that were, but, thanks to photography, we may be the possessors of the shadow, though the substance be beyond our reach. It is here we feel the value of photography, and whilst looking through the

album, each particular portrait calling up a fresh history, we may exclaim with joy, "Oh, memory, fond memory, when all things fade we fly to thee!" The preservation and veneration of our photographic albums is one of the best means of keeping up a wholesome state of mind in young people living away from their friends. It has indirectly a moral action, for the presence of good is generally productive of good, and we could not or ought not to have the portraits of persons constantly before us, of whose virtues we are assured, without becoming unconsciously possessed in part of those virtues; thus portraits are continually exerting over us a powerful, though silent influence.

One of the first requirements in many leading branches of life is a knowledge of drawing. The study of this is long and requires certain aptitudes. All students have not the means of purchasing that great desideratum "a voyage through the more classical or artistic countries." 'Tis true that sometimes a student gains a prize of money, enabling him to make the tour of Italy or Greece, but many have run the race, and only one perhaps has gained the prize. Here then comes photography to the aid of unsuccessful competitors. They cannot go to those places, but those places by photography are brought to them in all their richness. Paintings, sculptures, rare collections of art treasures—all are within their reach. Those marvels of art of the great masters—Rubens, Raphael, Vandyke, Del Sarto, Durer, Martin Schœn, and all their host, are, thanks to photography, vulgarized over the whole of the civilized world. Now, is the influence of such works as these productive of good? Is mankind benefited by the study and advance of art in general? I think there is only one reply, and that in the affirmative. If so, then the principles of photography ought to form a part of the education given in our schools of art. The illustrious Paul de la Roche did not fear to say, in the presence of the members of the Academy of Science, "Photography brings to such perfection certain essential points of art, that it ought to become an object of study and observation to the greatest painters." Thus one of the greatest modern artists says it must not only become an object of observation, but of study to great painters; more particularly then ought it to be one for art students. We must not forget that photography is not what it was some years ago. One might then have said, "Ah, but your photographs are only of partial value, for you look on a beautiful picture to-day, and lo, on the morrow, it has begun to fade." Yes, it was so, and how proud are we lovers and disciples of our delicate art to be able to say it was so, for thanks to Fox Talbot, Tessié de Mothey, the valuable processes of Woodbury, Albert, Photogravure, Photo-lithography, and all the long list of photo-mechanical processes, we can now claim for

photography perfect stability; and so long as the paper on which it is printed will stand the wear and tear of time, its photographic impression will cling to it as ivy around an old tower. And at what cost are these unalterable and faithful reproductions to be obtained? From a few pence to a few shillings, for by reason of the peculiar nature of these processes, a large number of impressions may be turned out at a very moderate cost. Should there be students so poor as not to be able to possess copies, they might have recourse to the public ones. I might mention here that it would be well for the Government to present series of collections of interest to the different museums, University, libraries, scientific bodies, mechanics' institutes, &c., and interchange with other countries possessing similar collections, thus familiarizing the eye to good work, and keeping up a lively interest for progression among all classes, as well as procuring a constant and perfect record of what was for future generations. In this manner both present and future would alike benefit from it. The Right Hon. G. J. Goschen, speaking at the Liverpool Institute, at the distribution of prizes, says:—"Education must deal with men's lives as well as qualify them to earn their daily bread. He wanted education to ennoble, brighten, and to beautify their lives; he wished it to increase their pleasures and their powers of happiness. It was not sufficient that man should have only knowledge of his own surroundings." It is very true, man to be thoroughly happy must possess an educated mind, and surely photography is of great assistance in helping forward this education. An objection might be made that it would become too expensive; but that is a mistake, as the public sale of such collections would more than cover the expenses. It might also be urged that it would be unfair to compete with the public dealers. Here, again, is an error. If in England where there are several large and influential photo-mechanical establishments in full work, the Government have thought it advisable to do so, how much more reason would there be to do so in a young flourishing country where no public establishment of the kind exists. I refer to the photographic establishments at the British Museum and South Kensington; and it would be a boon to the artistic interests of the country, as well as a means of making it better known in Europe if the Government would deal liberally with the question. What would be more interesting to us than photographs taken from nature of Captain Cook and the scenes of his early discoveries. The one we cannot possess, the others we might.

Let us now turn to surgery, and see how the camera makes known in all their dreadful aspects, the various afflictions of human nature—how photographs of the different stages of certain diseases, assist the student in his pursuit

of knowledge respecting them. In cases of deformity and fleshy protuberances, I have heard medical men state, that indifferent photographs were far preferable to highly finished sketches. Here again I would remark that photography offers its assistance for the general good, and in particular for the suffering part of humanity. How does physiological research accept photography? Dr. Stein has succeeded in producing photographic records of the pulse-beatings, tones given from musical instruments, and recently astonished the scientific world, by photographing upon a sensitive plate the sounds produced by the human voice. In speaking of this wonder, the *Photographic News* says:—"As the tones vary, so the waves of the line occupy more or less space, or are taller or shorter. Shrill notes or tones, where the vibrations are rapid, are represented by many steep waves; low or bass tones, where the vibrations do not follow each other so rapidly, produce but a few waves in a line."

Another practical use of the camera is thus described by Mr. Baden Pritchard. One instance taken from the war of 1858 is especially interesting. The Austrians held Venice at the time, and to protect the harbour, torpedoes were laid down, which were fired by means of electricity. A camera was built overlooking the harbour, and upon the white table of this instrument were reflected the waters of Venice. As the torpedoes were sunk one by one, a sentinel in the camera noted the place of their disappearance with a pencil, giving each torpedo a consecutive number. A rowing boat in the harbour described a circle around the sunken torpedos indicating the zone of their destructive power. The sentinel again with his pencil made a corresponding ring upon the camera table. In the end, therefore, when the harbour was apparently free from danger, a very effective means of torpedo defence was established, the key of which was only to be found in the camera; here the sentinel had wires in connection with every torpedo, and was in a position to fire any one as he pleased. The Prussians used the process of photo-lithography largely during the Franco-German war. They reduced plans of the part of the country they were in, and distributed them to the several army corps. One firm alone printed 300,000 impressions. Another most interesting application of photography was made use of during this same war by the French during the siege of Paris. Private and public despatches were printed upon a sheet of paper containing about 300,000 letters. This was reduced by means of photography to about two inches by one and a half, then printed on films of collodion, each weighing about one grain, and containing the matter of several newspapers. Several of these despatches were rolled up into a quill about three inches long, and by means of pigeons, sent to all parts of France. Here, on their arrival,

they were magnified by the oxy-hydrogen apparatus, and rewritten by newspaper authorities and others interested therein. Upwards of 100,000 despatches were received in Paris during the siege by these means.

In astronomy, we find the assisting hand of photography. It seems to have in this case a twofold purpose—obtaining the images of the heavenly bodies for the purpose of measurement, and for producing pictures of some of these bodies with more accuracy than could be obtained by hand-drawn ones. Berkowsky was the first to apply photography to astronomy, by obtaining daguerreotypes of the eclipse of the sun in 1851. Warren de la Rue and Secchi of Rome used the collodion process for the same purpose in 1860, and at the present time all the European Governments use it in connection with astronomy. The *Scientific American* says:—"Astronomical photography has recently assumed a higher place than as a mere mode of reproduction of the images seen through the telescope. It has, in fact, become an important means of discovery; and the researches of Professor Janssen of Paris, has shown that photographic pictures reveal phenomena otherwise perfectly invisible. It was through such prints that he discovered the photospheric network round the sun." Another proof of its utility was furnished during the late transit of Venus, and another not less important exists in the fact, that the British Government possesses four photoheliographs at different stations under Government supervision. The French Government, however, possess the most important set of photo-astronomical instruments in their splendidly fitted-up ateliers at Meudon Observatory, near Paris. There daily photographs are taken of the sun, the average exposure being one-twelfth of a second for an image $\frac{8}{10}$ of an inch in diameter. Sir George Airy gives another proof of its utility when he says, "The computation of the photographic records of the barometers, from 1854 to 1873, has so far advanced that it is asserted positively that there is no trace of lunar tide in the atmosphere, but that there is a strongly-marked semi-diurnal tide, accompanied by a smaller diurnal tide." I must also allude to Professor Draper's late discovery of oxygen in the sun, and perhaps nitrogen, which discovery was made by the aid of photography. (*Vide* paper read before the American Philosophical Society, July 20, 1877.) Professor Janssen's photographs of the sun are now causing as much excitement as De la Rue's photographs of the moon did some years ago.

Another important use to which photography is put is jurisprudence, its rigorous exactness rendering it particularly fit for such an application. In many instances truth has been able to be indelibly proved by its means. In

1852 Monsieur Christolphe proposed to the French Government that all prisoners should be photographed prior to their discharge, and notes of their cases and biography attached to them, but nothing important was done until after the reorganization of the country in 1871, when Monsieur Lombard succeeded in obtaining permission of the authorities to establish a photographic department in the prisons. Some idea of its usefulness may be formed when it is stated that it already occupies nine operators in Paris alone, where there are several stations, one being used exclusively by the Morgue Dépôt, where are laid out all persons found drowned or otherwise killed, and whose residence is not known. All bodies brought in are immediately photographed, and, when buried, the photographs are put in the register. Thus, persons seeking lost relatives or friends may daily be seen consulting this shocking but useful record. Views are taken where crimes have been committed. Even caves or cellars do not escape, for by aid of artificial light, such as magnesium, or oxy-hydrogen light, or others, these interiors are perfectly photographed—in fact nothing is omitted to assist Justice in her decision. In cases of arson, the condition and position of the furniture is faithfully depicted. Thieves' tools are photographed; in forgery enlarged proofs are made so as to detect the slightest irregularity; and in many other ways does photography make its services appreciated in connection with jurisprudence. The photographic albums of well-known criminals are also sent by one European nation to another, and all the sea-port towns are possessed of them, which, in the event of prisoners or untried persons trying to make their escape by sea, becomes of great service to the police. So photography in this case again shows her great utility.

Let us now briefly turn to industry, and see how eagerly her services have been taken up here. Its adaptability is so great that there is really no end to it. Copying machinery, porcelain, glass, books, manuscripts, &c., &c., illustrating works by mechanical means, reducing plans, burning in portraits on porcelains, making blocks to be printed with text,—in fact one might enumerate hundreds of different ways of employing it, but the most perfect proof of its usefulness is in the fact of the existence of so many splendid photomechanical firms in different parts of the world, particularly in Europe—such as those of London, Paris, Berlin, Vienna, Munich, Dresden, Brussells, St. Petersburg, Lisbon, &c., &c. The Woodbury Company, and Heliotype Company, in London, are principally occupied in illustrating books. A matter of considerable interest to geologists has recently been made in the Trafalgar Coal Mine, belonging to Messrs. W. and T. Brain, in the forest of Dean. One of the roads in the mine required repairing, and in cutting away the walls, the workmen exposed two very

large "stools," known by geologists as sigillariæ. This is the fossil form of the trunk or stem of a tree which grew during the age in which the coal measures were deposited, and its genus contributed more than any other to the formation of coal, but it differed much from the forest trees such as we are acquainted with in these days. Dr. Hooker suggested that it probably belonged to the tree ferns found in tropical and semi-tropical countries. It being a very rare occurrence, all desired to have a drawing made, when Mr. G. Emlrey (master of the Gloucester School of Science), accompanied by a few friends, visited the pit for the purpose of making some photographs of it. The dry plate process was employed, and the subject was lit by the use of magnesium wire—certainly the photographs of such a subject were more valuable than mere hand drawings.

It would be foreign to the nature of this paper were I to enter into a long dissertation as to whether photography is a fine art or not. Monsieur Gaston Tissandier says, "It is dangerous to wish to establish a parallel between photography and painting, which differ essentially in their processes; at the same time, it appears to me unjust to deny to photography the rank of one of the fine arts." Now we have already heard the opinion of that great authority, Paul de la Roche, who says that it ought to become a study and observation to great painters. Much has been written for and against its introduction among the fine arts; and I shall make but a few remarks concerning it. I think if we keep within the acknowledged description of fine art, we shall find it to be one. The fine arts, as generally understood, comprehend those productions of human genius and skill, more or less addressed to the sentiment of taste, or to the imagination. This, therefore, may be opposed to nature, and are we to conclude that effects opposed to nature are really fine art, or should we take our standing-point from nature herself? For my own part I start from Mr. Ruskin's estimation of art when he says, "Art should be full of truth or full of use;" or again, "Let me finally tell you, and with all distinctness possible to me, that the main business of art is the service it renders in the actual uses of daily life." I think it a degradation to art if its sole object is simply to flatter and please the senses. This is luxury, and luxury means decay. Let truth and utility be its high aim, and although many may laugh and others turn in scorn at this treatment of their idol, yet the day is dawning when art will no longer be valued by its imaginary figures and luxurious painting, but by its truth and the amount of service it renders to humanity. Mr. Cocking has stated, "In fine art the materials are so plastic that they follow and obey the also plastic emotional feelings which guide their use, and hence, in fine art, an imitation is something independent of and different

from the subject imitated. Whereas in photography the materials are not plastic, being unyielding scientific facts, which in their workings are not subject to plastic emotional feelings, and hence the imitation is dependent on, and cannot differ from, the subject imitated." This is true only in part, and I claim for photography such emotional feeling as guides it in the difficult task of imitating, and the plastic power according to the nature of the materials necessary for the carrying out of the task. How, I would ask, is this power of altering nature at will, to serve our likes and dislikes, worthy of the appellation of fine art? Cultivated minds differ as well as uncultivated ones, and painters are no exception to the rule. One will pronounce a piece of work a marvel, and another will disclaim it. This being so, and following out the theory of Mr. Cocking, fine art may really reverse nature altogether—inasmuch as it has become independent of and different from the subject imitated. This may be called a creation. Strange use of the word; if so, it is a creation formed after having seen and studied the original, and so becomes but a bad imitation. We surely do not presume to improve upon nature, for what could we produce even equal to the colouring of a simple wild flower? We can only imitate. Composition is simply an imitation of nature, and he who keeps nearest to her is the most faithful representative of fine art. The colourist can do a great deal; but he can only copy nature, and in attempting more shows weakness. Whatever combinations we may choose to make and call them creations, they are, if opposed to nature, simply dull and meaningless imaginations, proceeding from a wandering, if not a diseased brain. Now, it was said that the materials used in photography were not plastic, by which I presume is meant that they are not under the same control as paints and brushes; relatively they are under the same control when used by those who know their properties and actions. As in painting so in photography, two things are required, materials, and the necessary amount of brains to use them to advantage. These are represented by canvas, paints, and brushes, and photographic materials on the one part, and by a knowledge of certain laws called "rules of art," on the other part, aided by a keen perception of the beauties of nature. In the matter of the first I fail to perceive any difference; canvas, paints, and brushes are as much materials as camera lenses and chemicals; and in the knowledge of how to use them I also can see no difference. Let us dismiss from our minds the picture too often drawn, of a photographer being a sort of wooden man, a man of tin, or anything else, brought out when required, wound up and set to work; when finished with, carefully put away for future use. But take the travels of, and follow up such men as Vernon Heath, Braun, Mundi, Wilson, England, and others; see them up with the lark, searching after the beauties of nature, watching all the various

changes of light, seeing their subjects under all phases, looking for a happy spot where the combination of a picture may be in harmony with the rules of art, and where nature is seen in her most beautiful aspect—in short, the brain working hard from morning till night. Not only have they to use equal judgment with the painter in his selection of light and position, but the practical part of their work is more difficult, and requires more consideration and patience. They have also many things to think of in assisting chemicals or making them plastic in their hands. They may partially expose one part and not another; they may develop one part more fully than another; one subject may require a short-focussed lens, another a long one—one require a collodion with much more bromide than another. Again, in the after-printing of their subjects they have large scope for judgment and taste. In short, the proper working of photography requires the same amount of intellectual faculty as is required for painting or for sculpture, and their tools are in their way equally as pliable. The loss of colour in the photograph is represented in painting by loss of valuable and truthful detail. When photography has the power of representing by natural means subjects in their natural colours it will be proclaimed the first of the fine arts. Photographers, as a rule, have neglected art-education; but that has nought to do with the fact of photography being a fine art. All men who sit before an easel and handle their materials are not artists, any more than all persons using camera and chemicals are photographers. Are the splendid enlargements by photography seen in London, Paris, Vienna, Rome, &c., merely mechanical works? Do they lack emotional plastic feeling? Those grand pictures of ancient Rome, or the quieter scenes of rural life—do they call forth no sentiment? These are all imitations, but the grandest that art ever saw—imitations that it is given to photography alone to produce, for their perfection and truth defy all other processes. Here then is another reason why it should be taught in our Schools of Art and Science. It is yet a young art, and seeing what it has already done, what may we not expect from it in the future? Take it then by the hand and give it its place ungrudgingly. If you do not, sooner or later it will take that place by the force of its truth and utility.

We will now come to one more application of photography, which, although coming last, is not of least importance. I refer to its applicability to educational purposes. It is well-known the great difference that exists between reading of any subject and seeing illustrations of it. The latter must of necessity fix itself more lastingly on the brain. Now photographs are acknowledged to be, in certain cases where truthfulness is required, better illustrations than any engraving process can be

for educational purposes; therefore large ones become very valuable. What then ought to be the value set upon the method that allows us to procure real photographs upon a screen varying from 6 to 30 feet in diameter? I speak now of the adaptation of photography to the sciopticon and oxy-hydrogen apparatus. Here is a special manner of teaching, at once the most perfect and the most interesting, allowing any number to see the illustration at the same time, the number depending solely upon the size of the hall used, which illustration bears truth in every line. There is really no limit to this mode of instruction—thousands upon thousands of subjects are in the market already, embracing all branches of knowledge. Science, art, travels, history—in fact, every subject may be treated in a manner which is calculated to produce most wonderful results. It was introduced into France with great success, and is still used in connection with the lectures in the military and other large schools. It can well be understood the great charm these monster photographs would produce on old and young alike. And how full of interest—look at those striking views of that great Indian empire. Alas! how very few of our countrymen know anything of its grandeur? Then there is much to be learned about those wonderful people the Chinese, the Japanese, the wilds of America, Africa—and, indeed, what is there not that we do not all want to know something about? But our occupation may forbid our roving, or pecuniary matters stand in our way, or again, ill health may prevent many from travelling. In all these cases photography comes again to our aid. Then, why let our rising generation so long remain ignorant of these places—why not illustrate our geographical lectures by these grand means by which the manners and customs of various nations can be so vividly described? I feel that I could dwell longer upon this subject than the nature of this paper would allow, for the knowledge of our fellow-creatures is such a good, interesting, and important one, and the amount of ignorance, or the want of knowledge of other nations, even among Europeans, is still so great, and the bigoted ideas of past years so firmly fixed to us, that it will require a large amount of patience and careful teaching ere one-half of the civilized world understands, willingly or not, the virtues and abilities of their neighbours. The gradual extension of this mode of teaching, for public assemblies, schools, &c., is one that will serve to enlarge our minds and refine our ideas, that we may be able not only to see and appreciate the wonders of nature all around us, but that we may, as nations, become more familiar with the various countries of the world, and be able and willing to render justice to the different peoples for their various virtues and abilities; and knowing these, we can all of us use what we ourselves are deficient in, and so increase in

knowledge to the general welfare of the human race. Thomas Pearsall, F.C.S., in an article in the "British Journal of Photography," on photography, philosophy, and civilization, says: —"To the literary world the power of light has become so obedient that the very choicest stores of learning can be copied with a marvellous service, the choicest, priceless books, and manuscripts, can be copied with such exactness that the strains and ravages of time become matters of pictorial interest and truth—they can be copied, condensed, or enlarged, and even transferred from one material to another. In the current literature of the day, especially devoted to arts, science and manufactures, authors, artists, engravers, and publishers have a rare aid to pictorial illustrations. Take the book-illustrations by wood-engraving. The wood-engraver, in a sort of Chinese fashion, would and could only follow the lines traced for him by a special artist on the wood block. This artist was hampered by having perhaps a crude sketch on the one hand, to be followed out by such lines as the engraver could cut. Now, the wood block may have a photograph impressed upon it, and thus, having truth of faithful outlines, due proportion, and correct light and shade, both artists and engravers can shape their lines to suit the texture, and their own art sympathies of expression. Metal after metal has been employed until a solid block of metal enables the picture of a once delicate film of matter acted upon by light to be multiplied and worked with all the appliances of mechanical power." He concludes his article by saying :—"The caverns of the deep will soon be explored, and light will shine in the valleys of deep waters, will point to the dangerous rocks to shun or how to follow a safe track, if mists, darkness, or fog, obscure the mariner's sky. The magnesium and electric lights will shine out if the sun at Stratford-le-Bow does not shine through fog and murky air; and as in the evening sky we seem to find islands in a golden sky, so our thoughts have a grateful feeling for the obvious union of photography, philosophy, and civilization, and we rejoice in such reveries in "gloaming time." I might go on for almost volumes on the great advantages of this particular mode of educating the mass, but I must conclude with a few remarks by John Beattie, Esq. :—"There are few," says he, "if any, branches of science not indebted to photography, but especially those immediately connected with man. It has rendered anthropology comparatively easy. Ethnology is the science of character—the essence of all social science. Now photography is every day forcing us to see how social character is so directly connected with form. No sketch or engraving can please us—it must be a photograph; then the social influence of photography is seen to be great in the multiplication of works of art. I trust we are coming to a time when all things will be valued according to their true educational worth, in fact in proportion to their sociological

influence and power to reveal man to man, and man to himself, and above all to cultivate the sentiment of beauty in the popular mind. Photography is made to bring under popular view all that has been rare and almost unattainable, the forms and pictures of suns and planets, the portraits and forms of life whose whole existence is spent in the eternal darkness of deep ocean. Surely then the educational influence of photography is immense, and must take its value from so great a social power. The use of photography to social science could never be supplied by another art—nothing else could so hold up the mirror to nature." From the foregoing we must make the following conclusions :—That the study of the good and beautiful is necessary, and of benefit to the human race. Photography I have shown to be one of the best means of vulgarizing these studies. It follows as a matter of course that photography should therefore become a serious study amongst us, and no place better for it than in our schools of art and science, where a knowledge of the mode of working this mighty power might be made easy to all students. A course of six months' instruction in any one branch of photography would be sufficient to make one acquainted with its principles, and enable the student to work alone, where, by the aid of any of the well-written works on the subject, and the many practical journals devoted to its literature, he would be able to continue prosecuting his studies without the constant presence of the professor. The cost would be but small compared with the results, as one professor could visit many schools. What a great advantage to the Government of a country having its photographers spread all over its surface. What a wonderful collection of valuable information could be thus obtained. Nor must the professor be simply a teacher or lecturer of his art—he must be a lover of it, so as to bring out boldly and earnestly its advantages, and so by his own fervour and devotion make ardent disciples. No study could possibly become more popular—so full of wonder, newness, and marvels at every step, and constantly unravelling to us Nature's most beautiful and profound truths. I trust that abler pens than mine will take the subject in hand, and that the time is not far distant when we shall see announced the opening of a course of lectures, like those in the practical museums of France and Belgium, on photography, in connection with the schools of art and science, and by these means a good training school for our young professionals will be started, who will thus have an opportunity of getting a sound and practical knowledge of photography —when, by successive examinations, a wholesome desire to excel may be created, and finally crowned by some recognized degree or mark, that will have raised the careful student to the competent and experienced operator.

On Music.

By M. Jules Meilhan.

[Read before the Literature and Fine Art Section, 29 November, 1878.]

When asked a few days ago by our honorable Chairman to write an article or essay on Music, to be read before this learned Society, I naturally felt gratified at having been chosen for this task, as well as at being, as I believe, the first professional musician entered on your list of members. I must then commence by thanking you for this mark of your esteem for me as an artist, and my second duty is to assure you that I shall always do my best to prove worthy of it, by contributing my mite towards the progress of this Royal Society of New South Wales.

The subject of this address has been suggested by the apparent state of humiliation in which, it seems to me, music is vegetating in this Colony. I notice with amazement, for instance, that many persons here, even amongst the learned, question the claims of music to the highest ranks of excellence as an art; and it should therefore be interesting to discuss this question, and try to comprehend why music in this Colony is not what at all times it has been, "*primus inter pares.*" I pass, without waste of time, the strange fact that amongst our citizens have been found some asking whether or not music *is* a fine art. Well, controversy on such a question is out of place, and it is certain that any chemist worthy of the name would observe the same silence if asked if chemistry is a science, as I, and all true musicians, must do when asked if music is a fine art. I also pass by quickly the fact scarcely less strange of there existing persons to whom music is simply a painful or disagreeable noise in which they can distinguish neither tune or rhythm. Such cases must be referred to the examination and discussion of our Medical Section. Now, there are other persons who do not like musicians, and who visit on music a part of the contempt they feel for its votaries. I knew, however, a rich amateur who, when asked if he loved music, replied: "Do I NOT love music! Why, sir, I love it so much that musicians themselves have been unable to disgust me with it." Well, the test is sometimes a severe one. Again, there are side questions, as that Nature has not made us all alike, and that it would therefore be as ridiculous for a musician to expect that every one should like music, as for an astronomer, for instance, to be indignant that every one cannot calculate the parallax of the sun.

That music has always been considered and written of in all times as the most popular of arts is not to be denied, and there is truth in the assertion, inasmuch as there is a kind of music that speaks to every one. I speak of course of the simplest, which, for some nations, is the only kind, consisting of a few airs and dance

tunes. A single voice or a single instrument, however rough, may be sufficient to produce such, and the infant, be it man or nation, is capable of enjoying such music. But as man or nation develops, something more is attempted, and the fine art gradually grows up from the infant seed; concerted music of every description, with its fanciful melodies and elaborate harmonies, leaves behind the mere dance tunes, and eventually asserts the glory of art, just as from the mere rough-hewn stone some great sculptor will produce to our wondering, reverent eyes the very image of the gods. In its progress, however, music recedes from the crowd, for the composer is no more the only producer of his works. Between him and his public is an immense distance, interspersed with obstacles of all sorts, unknown to other artists. A painter, for instance, composes a picture, and with the last touch of the brush his work is done; any one can see it; any one can even to a certain degree form an opinion on it. The work of the sculptor once finished enjoys the same privilege. Architecture, it is true, presents to its votaries more difficulties, and in this, as in some other respects, it is perhaps the art that most resembles music; for, when the architect has conceived and drawn his plan, showing all sides of the building carefully measured and numbered, his work is but at the beginning. Still, many can judge at least of its artistic value; many can anticipate what the effect will be when the structure rises from the ground; but once all the difficulties of builders and masons are surmounted, what a rich recompense to see grow into form the reality of his conception. Then any one, every one may admire, may criticise, every day, every hour. There stands the noble pile to outlive centuries of human beings, and to glorify by its harmonious proportions and beauty the memory of the man who was its architect. Its very ruins, in its age or possible misfortunes, sing his praise. And yet architecture is an art in which intellect alone works, and in which intellect alone is stirred to admiration. Now when the musician takes his pen, or, if I may be permited to use the more poetical expression of old, when he seizes the lyre, it is not only to create harmonious proportions of sounds, and to charm our ears with tunes as the architect charms our eyes with lines,—it is also to tell us what he thinks and feels, to make us think and feel as he does, to give us in fine something of his soul and of his very heart's blood, so that what has been said of the great condition of true eloquence, *Pectus est quod discertos facit,*" may be applied with at least equal truth to music. Whilst in other arts it is the artist we turn to admire, in music we forget the composer in the multitude of impressions with which he fills our hearts and brains. Whilst the chief business of other artists is to be clever in their craft, and to exert all their powers of observation, the musician should in addition be the student of human nature with its many passions, good and evil, its longings

after happiness, its hope and despair, its tenderness, its love and hatred, its generosity and meanness, and so down to the everyday moods and affections of indolence and vivacity, sullenness and good humour, &c.; and thus it is that he alternately drags and beguiles us through all the infinite variety of his fancy. He must be a Proteus ready to assume all shapes—man, beast, fire, stream—always deceiving those who do not know how to tame and to force from him his precious secrets. I admit, of course, that such an organization—one, I mean, so rich in natural gifts as well as in professional acquirements—is not to be found in all musicians; some, indeed, having been remarkable for a few only of the above requisites, have as a natural consequence been consigned to an inferior position in the judgment of posterity. Let us, however, take a good composer of the day—say the celebrated author of "Faust" and of "Romeo and Juliet." He commences an opera. One, two, perhaps three years of labour are before him. During all that time he lives in the world, spending an afternoon here, an evening there—garden parties, dinners, publishers' soirees—he must attend all the social gatherings to which the movement of his own social life as a genius and a favourite drag him. He must listen to sickly ballads at these places, to insane opera-bouffe selections, to empty crashing military band music. He must answer silly journalist questions, submit well or badly to the real and the would-be aristocratic smiles and praises lavished on him; perhaps even being hunted by some of those commercial firms who order music by the yard, he may find himself bound down to compose between hours, things which, good or bad, can add but little to his renown. But all this time the true musician must carry about with him, in his head and in his heart, his whole subject. When smiling to the duchess who drives by his side, he is perhaps sounding the passion of Romeo's heart, or keeping ever before his eyes the maiden purity of Juliet, or maybe the fierce quarrels of the Capulets and Montagues are sounding in his ears. And to give life to these human passions, what are his materials? The most fugitive of all—sound—the mere vibrations of the air. But these vibrations produced by different voices and instruments strike our ears and convey to our souls the expression of the composer's fancies, in the proportion of his genius and of our individual musically receptive power and of our sympathy with him. Not to digress, however, let us say the composer has finished his score; that is to say, about 1,500 pages large quarto size, closely covered with fanciful dots, lines, zig-zags, serpent-looking lines of correction, and hieroglyphics of all sorts, expressing all he has in him of talent or genius. As it stands now it is a work, but who knows it? Nobody. A few of the initiated perhaps might look through that labyrinth, and catch a glimpse of its beauties; but

who cares to spell slowly and painfully through such a manuscript with its numerous abbreviations, so deceptive that often the eye mistakes one clef for another, thus altering sufficiently the sound to put you all out and oblige you to read again the twenty or thirty lines which performed simultaneously are to produce the effect of that portion of the work. No one cares for a task so hard, and no one undertakes it. It is for this reason that judges of musical competition require from the candidates a pianoforte arrangement and reduction of the general scores, and it is for this same reason that young composers find it so difficult to present themselves fairly before the world; for in many compositions the pianoforte score is powerless to give any sufficient or correct idea of the whole work. Of course in the case of an already celebrated composer, matters run smoothly enough, as you will see. It is then a matter of course that the opera is to be performed, and it is not difficult to find a publisher to buy the copyright. He immediately prints the pianoforte score for the assistance of the artists at the rehearsals. Then the general score is delivered to the copyists, who extract and separate the parts of the various instruments and chorus-voices, and this is often the affair of many weeks, after which only *really* commences the practical labour. I do not know if an astronomer finds that stars of the first magnitude or those of minor importance cause the most *embarras* in the heavenly system; but I am quite sure that, if the former are great trials to a composer, the latter are often ten times more irritating to his nervous system. The Signora A. would like a cadenza added to this or that air; Signor B. must have a B flat or a C at such and such a place to show off his best notes; some one else desires the time made quicker or slower to suit him; and another, perhaps, worries to have a cut made in his part; and so on *ad infinitum*. In vain the distressed composer tries to make each one in turn comprehend that his request is out of keeping with the style of the music, the sense of the words, or the dramatic situation. What signify such trifles to stars who know their importance! They have spoken! Make the required alterations, or they throw up their parts! The unhappy composer has to yield; and to save the life of his work he, perhaps, maims or cuts off a limb. I doubt if there ever existed a composer who has not had to bow his head before the tyranny of the stars. It is true that, in a few rare cases, with the greatest stars this may have been for the best, practical experience being an excellent guide for genius itself, but these exceptions only prove the rule. I may mention as a case in point two of the finest scenes of the French opera—Rachel, in "La Juive," and the duet closing the fourth act of "The Huguenots," which we owe to the suggestions of great tenors. But against these exceptional cases are numberless deplorable passages introduced to please singers in certain

other works, mostly French and Italian. Happy composers when such so-called improvements are only made after their deaths, as in a case which occurred not long before I left Paris, I remember. A certain Madame Hisson, then singing at the Opera, took it into her head to try her hand at improving her part in "Der Freischutz," and so violently did she resent the very moderate and even courteous critique on her interpolations which appeared in the *Figaro*, that she actually drove next morning to that newspaper office; and when in obedience to her request the writer of the article in question politely presented himself at the door of her carriage, she lent forward, and, with all her strength administering a couple of slaps to the outstretched face of the bewildered victim, she drove quickly away. Of course, this circumstance was calmly recounted in full in next day's *Figaro*, with the natural remark that such conduct, especially from the fair sex, on whom it could not be returned in kind, left but one course open to the critic, which would be to pass them by with merely the observation that, as they not only professed to have arrived at perfection and to need no improvement, but also were ready to assert by the valour of their fair hands their being better interpreters than the composers themselves of great works like "Der Freischutz," they must clearly be above all criticism.

To return to our composer's miseries. The stars restored to good humour, he has next to run the gauntlet of the manager—the interpreter of public taste; and if his energy or diplomacy has saved his work from some of the vandalism of the stars, it is to be feared it will not hold out against the storming of the director. Wagner himself, the despotic Wagner, had to give way when his "Tannhäuser" was rehearsed in Paris. In his own account of that unfortunate affair, he confesses he was obliged to modify his work in order to make room for a ballet, without which, he says, no opera there can succeed. It is true that the great tone-poet has long done with this mild spirit of condescension. Now, he not only imposes his own conceptions without suffering the very slightest modification, or the hint of such a possibility, but he forbids the audience to give any mark, even of approval, before the close of the act. It is related also of him that when, at the close of the Bayreuth festival, all the chief performers were clamorously called upon to reappear before the curtain to receive the applause they so well merited, Wagner's overweening personality taking alarm, he tyrannically forbade their obeying, and he made his appearance all alone before the public.

Well, it is not every composer, even though popular, who can afford thus to stand on his *dignity*, and composers therefore in general know well what it is to pass under the caudine forks of directorial tyranny; moreover, during the rehearsals there are

plenty of well-meaning friends to hazard their various suggestions —"Would it have a fine effect if the trombones had a note here, or if the oboe could be added to the flute there?" and so on; and these prick-points, without counting the necessary corrections of the faults of copy, make his life a real martyrdom.

At last the day appointed for the full and final practice arrives. Everybody is at his post. A sort of solemnity prevails on these occasions. Members of the Press crowd in with their note-books; provincial managers are there to see if the new work is one likely to suit the tastes of their special public. The composer, sitting near the conductor, is already prepared to give the *temps*, when, perhaps, as the last drop overflowing the cup, comes the indisposition of the prima donna, or some equally happy accident, involving postponement. Why the general disappointment and annoyance should be visited on the composer, who can tell? But so it mostly is; and, alas! he who is the most bitterly annoyed and disappointed of them all has no one on whom he has the right to fall foul of in his turn.

I will not weary you with further details. The first representation is generally the term of our composer's worst tribulations and anxieties, though of course success or failure equally delivers him up to the critics, and he must harden himself to every possible exaggeration—he is a demigod or a cobbler, a tone-poet or an organ-grinder; he is "ballooned" (excuse the word) up to the seventh heaven, or "diamond-drilled" (pardon again) to the bottom of hell. Anyway he once more breathes freely—his work is produced—it is known—he can do no more. He waits the verdict of time, and may perhaps never know it.

To return now to my assertion that the musician, or rather composer, has to struggle against many more material difficulties than have other artists, in the production of their works,—do not imagine I have enumerated them all in my rather lengthy sketch of our friend the composer. Alas, no! For the success of a work, good or bad, before the public, depends in *so* large a measure on the degree of perfection of the performance. The more beautiful the work the more perfect should be the performance, in order to show forth its varied charms, and this is why compositions that in London, Paris, Vienna, and Leipzic excite unbounded enthusiasm, create but little effect sometimes in other towns. Instance the works of Beethoven. If any man ever conquered a sublime position in the estimation of all those who love and understand music, it is Beethoven, whose illustrious name has become almost an object of worship. All his works have been published by hundreds of music-sellers, yet all have been enriched by such publications. There is not a serious amateur who does not possess a copy of his pianoforte sonatas. I know I myself possess four

editions of them, without reckoning duets, trios, quartettes, symphonies, &c. There is not a musical Society whose programmes do not contain some of his orchestral compositions. Beethoven to music is what Shakespeare is to poetry. It is, then, precisely to this same grandeur and perfection in his conceptions that we should trace the painful fact that few can enjoy the performance of his works here—that many are found wondering that such "heavy, fatiguing" music should be termed highest class, and that a few, whilst suffering martyrdom, tremble to see the future of art in this country compromised for ever by such well-meant but imprudent and inadequate productions of such masterpieces. Can I ever forget the performance of his "Fifth Symphony," as given here some months ago. Oh, the profanation of that splendid work! There was not a single bar without its mistake—time, tune, expression, movement, all went wrong—a veritable representation of chaos. Is it to be wondered at if those who heard that masterpiece of composition then for the first time left with weary, confused nerves, and an irritable conviction that there must be much humbug in the growing worship of the great master's genius? It must be remembered it is not easy to play high-class music. To build such cathedrals as Strasburg or Cologne with masons who have never worked but at the humblest of huts would be easier than to play Beethoven with musicians who have never achieved a scale in tune. And here is another difference between architecture and music. Whilst the architect needs but good workmen to carry out his work, the musician needs artists capable of comprehending the entire structure, so as each to be able to give to his part the exact proportions requisite in every passage to its perfect rendering as a whole. We must not therefore be surprised if music in this Colony has yet to take its proper place and that if not precisely despised in its present humiliation, it is as yet ranked only among the amusements which often fail of their purpose. Quite lately I was looking in the *Sydney Morning Herald* at Mr. Windeyer's bill on copyright, and I could not but notice that, speaking of the fine arts, the author provided for the painter, engraver, sculptor, and even for the photographer, whilst not a word was said about music or the musician. Nevertheless, he has read Plato's "Republic," where the great philosopher legislates at such length on musical matters that he actually goes so far as to fix in what way and at what times, according to their ages, people shall sing; and when Mr. Windeyer read for the University degrees, did he never see in books on æsthetics that music is generally esteemed the first of the fine arts? Doubtless he has known this, but has forgotten it; and I should be wrong to throw the whole blame, if so, on this modern legislator, since his obliviousness is, I dare say, largely traceable to the fact that music itself in this young community has

failed to remind him of its divine qualities and to assume its natural position. Again, the musical critics of our papers do not show either much knowledge of their subject, or much care for their task. Read over the hundred, say, of musical critiques of each year, and this is about the substance of them all :—"On such a day such a person gave a concert at such a place ; the attendance, though not very large was appreciative. Mr. A. sang with his customary success. Miss B. displayed such a power over her instrument that she elicited an encore. Mrs. C.'s charming song this or the other, never fails to be appreciated," and so on, from five to twenty lines, according to the number of artists not to be offended. One exception to this rule, however, I do recall, and that was in an evening paper, after one of Mdlle. Charbonnet's concerts, where the writer made an attempt if not at criticism, at any rate at analysis. He wrote, speaking of a stringed quartette, to this effect :—"Those who write for strings make use of dissonants not only of the 7th of dominant but of other 7ths ; they are not only employed singly, but also in sequences. This sort of sequences are to be found principally in Gounod's compositions." Now what would a painter say if he read in an art critique, "Painters who paint landscapes freely use yellow, not only alone but in mixture with blue or other colours, and these mixtures are to be found principally in the works of Millais?"

If I ask myself if the editors are responsible for these shortcomings, I believe I should answer no. It is true most of them must be aware that not a single member of their staff is capable of writing a musical critique ; but if spoken to of a reform in that respect they reply : *Cui bono?* If reproached with inserting useless and even wearisome and exhaustive articles on cricket, they answer : "Cricket here is a national passion, and is played in great perfection." Our cricketers are in *their* way, a sort of artists, and I must confess there is a show of truth and common sense in this retort. Artists complain that there is no public for the higher-class music. The fact is that many attempts at high-class concerts have been made in Sydney, both by private artists and by musical Societies. These concerts, considered apart from their intrinsic worth and interest, have been failures—I mean financially. I except, of course, those for which considerations of friendship, patronage, or charity, have done more than any musical enthusiasm. It is then apparent that music does not occupy its proper place among the fine arts in this Colony, and on this point no one will, I think, contradict me. Ignored by the learned, forgotten by the Legislature, overlooked by the Press, more or less forsaken by the public, the noblest, purest, and most intimately human of the arts is not even acknowledged as an art. Deeply, however, as I myself feel this miscomprehension of that to which I have devoted most of my studies, I

might say of my life, I do not despair of its future in this country, because I can trace its present humiliation to very natural causes, and I therefore see no reason that time and patience should not put the matter right. In so young a community as this every one is at work to make his fortune and to advance the Colony. To give a value to the waste lands, to make the city a centre of commerce, so as to attract population and money, are less the means to the end than the end itself; squatting, banking, buying and selling, and building, are the great pursuits to which all else is entirely subordinate; and of the liberal professions, two only push their way in so new a country, law and medicine, for moral and physical diseases follow us everywhere. In the struggle for existence the young Colony can spare neither time nor strength for more refined culture; but as time goes on, it follows that some families will, from wealth or official position, raise themselves above the mass, thus at once creating a demand for a higher and more refined education. Professors of various kind appear on the scene—a University is founded; but the means of the Colony being still limited, the curriculum embraces only the most indispensable matters of learning. No doubt some members of the Senate do not forget that music is one of the liberal arts taught in the mother-country, but they dare not ask the sum necessary for a Chair of Music from a Government which has already done so much. Then outside the University and Government primary schools, teaching is abandoned to private enterprise. The teachers arrive with the demand, and the pianoforte being considered as specially the instrument of the fair sex, it is the lady teachers who predominate; moreover, it is only the ladies who can find time for cultivating the fine arts. It follows that for a long period, therefore, the notion of music as a fine art is confounded with mediocre piano-playing and still more doubtful singing. In my present capacity of pianoforte teacher, it would be out of taste to repeat all the witticisms circulated at the expense of that most popular of instruments; but I may be allowed to say that the piano, by making music easy for the many, has contributed to lower its standard in the estimation of outsiders. Later on, new comers try to see if something cannot be done besides pianoforte and vocal music, and they attempt to form orchestras. The military bands are first called upon for their aid in the trial. Now military bands fail because the instruments used are not capable of producing anything but powerful, noisy music, and because that class of musicians cannot ordinarily have had that delicate professional training without which really good music is impossible. However, they do what they can, and to mend matters some well-meaning musicians endeavour to mix with these military instrumentists all the amateur talent available among the citizens. That this combination also fails is not wonderful, seeing that such

amateurs, being engrossed with very different pursuits since their arrival in the Colony, have mostly forgotten the use of their instrument, and can find neither time for private practise nor for rehearsals. All the same, say I, all honor to these valiant champions of art! Though working in a wrong direction, they thus direct the attention of a certain number of persons to the subject, and help consciously or unconsciously to the more serious and well-directed movement which *must* come in the course of time. Nevertheless, for the present, weighed by their own intrinsic worth, these attempts are far from putting music in its best light, for, as before said, high-class music requires high-class execution, and high-class execution *can* be obtained only from thoroughly educated musicians—musicians sufficiently masters of their instruments to perform to a nicety every sign of time and expression marked on their parts. Now, do we possess a sufficient number of such artists here? Assuredly not! Of course I speak only of those composing our orchestras and choruses, not of the fraternity to which I belong, nor of certain ladies and gentlemen I know who would be valuable acquisitions to our musical Societies, though for their own doubtless valid reasons they stand aloof. Under all these circumstances, then, it is not wonderful if, though often called upon to testify to the progress of music, and to endure high-class compositions, the public fail to fall in love with them. "Is that music?" they say. "Well, it is not worth the strain of listening to it, nor the trouble and expense we have been at to take our families to hear it." They are in the main right, and, what is worse, anything that repeatedly attempted repeatedly fails *must* be considerably depreciated by the process.

Having now endeavoured to trace to its natural causes what I term the state of humiliation in which music here vegetates, I must hasten to the consideration of how we might to some extent raise its standard, and so, gradually winning new allies and admirers every year, finish by lifting the divine art to the pedestal it occupies in Europe. I begin, then, abruptly by deploring what seems to me the mistaken zeal of some music-lovers in proposing to build a new music-hall. That the wretched accommodation of our present concert-rooms makes the attending a concert a very *uncomfortable* amusement is not to be denied, and no doubt the new hall would be a great improvement as regards seats and cloakrooms; at the same time, artistically speaking, had we a Gerant Haus here, would it alter what I have said of the performers; and if money is to be spent, should it be spent in doctoring the body when the soul is languishing? Poor performance is poor everywhere—we must not forget this; and it would be a small consolation for being told we did not know what good music was in New South Wales to hear it added, "but you *could* not have a finer hall!"

People might almost as well say, "But then Sydney harbour is so lovely!" No, the music-hall is not what most presses! But there are some other persons who suggest having practices of orchestral and vocal music. This scheme, though in principle better than the other, is practically, in my opinion, as powerless to serve the purpose proposed. You succeed in procuring, say, the names of twenty or thirty amateurs on your list. At the first practice five or six of these persons attend; at the next meeting perhaps a few more, or a few less; and this is your average luck through the season. Now, of these serious members—I say serious because they are in earnest and attend—few know enough to execute their parts even roughly. Dubious tune, fantastic time, indescribable bowing, &c., are among their characteristics—and this from no fault, mind you, of their own. They cannot do better. They have other pursuits, and have had no time to learn as music requires to be learned; or they have never been taught the necessity of sound grounding in an art they imagine an affair merely of pastime and a fair ear for music, as it is called. Knowing little more than the rudiments of music, they have perhaps been induced to join an orchestra just as they should have been sent to school, and thenceforward, proud to sit in an orchestra, they have neglected the most desirable and necessary studies—they have not seen that they were neglecting the real thing for an amusement which was destroying in them the artists they seek to be. Learning was, perhaps, not to their tastes. And yet learning alone is the way to progress; it is by trouble and learning we can alone hope to see music flourishing in our midst. It is useless to go singing in choruses if you do not know your solfège and the management of your voice—it is useless to sit in an orchestra when your fingers are stiff and heavy, and your comprehension of the music as a part and as a whole more than slender. The result of such labour is, at any rate to the audience, vanity and vexation of spirit (and a longing for home and bed); but let there be classes where aspirants for the orchestra and for chorus singing may learn slowly and surely not only their solfège, but how to manage their voice or instrument. Let us have a school for music as we have for drawing. Let us teach boys and girls in preference to men and women, and thus sow what we may reap. Let us build a solid foundation. I have always advocated this idea; but I have met with that too natural propensity of youth to eat the fruit before it is ripe. Those to whom I have spoken have listened to me, and acknowledged I was right, and then they went and did the exact contrary of what I suggested to them. A sound idea, however, should not be too easily silenced, and this of mine which after all is only the reminiscence of what I have seen or known to be done in other towns, is a very simple one, though perhaps its carrying out here might meet with a few

difficulties. I propose, then, the establishment of a school for music, in which boys and girls shall be taught the solfège, vocal music, and instruments. The teaching must be gratuitous, or at least at a merely nominal rate, say half a guinea for a course of thirty lessons, three times a week; children admitted to the school should be between 7 and 15 years of age—any older applicants would require a special examination before being admitted. Four perfectly competent teachers would be sufficient to commence this scheme; one for solfège, one for vocalization, one for stringed instruments, and one for such instruments as the clarionet, flute, hautboy, bassoon, &c.—at any rate until time and success would permit of having a special and clever teacher for each branch, not excepting harmony and composition. Perhaps only two teachers—one for solfège (boys and girls) and one for stringed instruments—might do for starting the affair. As far as these two teachers go, I am happy to say I believe there would be little difficulty, there being in Sydney an artist whose disinterestedness in the cause of musical progress would doubtless lead him to accept gladly the class of stringed instruments for love of art. The artist to whom I refer has already offered his services, though in a slightly different line, to the Academy of Art; and I cannot doubt but that he would be willing to modify, or even altogether give up, his project of practices, if such a school as I propose were seriously established, either in connection with the academy or as a distinct institution. And for the solfège teacher I can answer for another who would do the work on the same terms. Under these circumstances, when the only thing requested from those whose patronage would be desirable is countenance and a little warmth of sympathy, ought we go on as now—dozing, if not slumbering? No! we must awake; we must bestir ourselves and make our step forward in the right direction. There are in Sydney more than fifty influential amateurs of music. Let them combine with the Academy of *Art*, about to assume the title of Academy of *Arts*, to help that institution to carry out its new aspirations. Let them give to music the prestige of their position in the State or in society, so that both students and teachers may know and feel that their work is followed with interest by those whom they are accustomed to esteem and respect. What is money in these matters of art compared to distinguished and intellectual patronage? Nothing! We can do almost without money, but we must have moral and intellectual support—artist disinterestedness and zeal. Further, we shall need a room, a black board, and a few desks. If New South Wales can afford these few essentials, we must not despair of the future of music in this Colony.

SECTION H.—MEDICAL SCIENCE.

DURING the session 1878 the Medical Section of the Royal Society held eight meetings. At the first meeting, on April 12, Mr. H. G. WRIGHT was elected Chairman, Messrs. CLUNE and ROBERTS were appointed to the Committee, and Messrs. JONES and MACLAURIN were continued in their office of Secretaries.

At the other meetings of the Section numerous papers were read of a very interesting character, and many pathological specimens were exhibited.

P. SYDNEY JONES,
H. N. MACLAURIN,
Hon. Secretaries.

SECTION I.—SANITARY SCIENCE.

Report of the Social and Sanitary Science Section of the Royal Society for the session of 1878.

Sydney, 19 December, 1878.

To the President of the Royal Society.

Sir,

I have the honor to submit the following report:—

The first meeting of the session was held on the 15th day of April last, when Mr. ALFRED ROBERTS was elected Chairman; Professor SMITH, Dr. BELGRAVE, and Messrs. WRIGHT and BEDFORD were elected members of the Committee, and Mr. HARRIE WOOD was chosen Honorary Secretary.

At subsequent meetings the subjects Vital Statistics and the Form of Certificate of the Cause of Death were further considered; but owing to the absence from Sydney of some of the members of the Section, and other causes, the course of action to be pursued for remedying the defects found to exist was not definitely agreed upon.

It is hoped that during the next session these and other important matters will be dealt with, and that the Section will be able to offer some valuable suggestions thereupon.

I have, &c.,
ALFRED ROBERTS.

APPENDIX.

ABSTRACT OF THE METEOROLOGICAL OBSERVATIONS TAKEN AT THE SYDNEY OBSERVATORY.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE $10^h\ 4^m\ 46^s$; MAGNETIC VARIATION 9° 25′ 2″ East.

JANUARY, 1878.—GENERAL ABSTRACT.

Barometer At 32° Faht.	Highest Reading	30·103 inches on the 23rd at 9 a.m.
	Lowest Reading	29·390 inches on the 15th at 5 p.m.
	Mean Height	29·853 inches.

(Being 0·088 inch greater than that in the same month on an average of the preceding 19 years.)

Wind... ...	Greatest Pressure... ...	14·6 lbs. on the 21st.
	Mean Pressure	1·1 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	S.

(Prevailing direction during the same month for the preceding 19 years, N.E.)

Temperature	Highest in the Shade ...	86·9 on the 10th and 15th.
	Lowest in the Shade ...	58·8 on the 22nd.
	Greatest Range	22·2 on the 10th.
	Highest in the Sun ...	145·0 on the 28th.
	Highest in Black Box with Glass Top	203·5 on the 28th.
	Lowest on the Grass ...	53·2 on the 6th.
	Mean Diurnal Range ...	12·4
	Mean in the Shade ...	72·5

(Being 1·2 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	94·0 on the 15th.
	Least	50·0 on the 7th.
	Mean	69·5

(Being 3·3 less than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	12 rain. (No dew.)
	Greatest Fall	0·888 inches on the 22nd.
	Total Fall	0·636 inch. 65 feet above ground. 1·096 inch. 15 in. above ground.

(Being 2·682 inches less than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	8·791 inches.
Ozone... ...	Mean Amount	5·8

(Being 1·1 inch greater than that in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	4
Cloudy Sky...	Mean Amount	6·6
	Number of Clear Days ...	3
Meteors ...	Number Observed ...	2

Remarks.

The barometer has been above the average, and the temperature, although on no day has it exceeded 86·9, yet gives a mean 1·2 above the average for 19 years. Generally, the rainfall has been light; but along the coast good rains have fallen, the highest being 8·93 inches at Port Macquarie.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 49s; MAGNETIC VARIATION 9° 25′ 2″ East.

FEBRUARY, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·213 inches on the 25th at 9 p.m.
	Lowest Reading	29·499 inches on the 23rd at 3 p.m.
	Mean Height	29·870 inches.

(Being 0·069 inch greater than that in the same month on an average of the preceding 19 years.)

Wind... ...	Greatest Pressure... ...	10·1 lb. on the 6th and 8th.
	Mean Pressure	0·9
	Number of Calm Days ...	0
	Prevailing Direction ...	E.N.E.

(Prevailing direction during the same month for the preceding 19 years, S.)

Temperature	Highest in the Shade ...	91·1 on the 23rd.
	Lowest in the Shade ...	62·5 on the 27th.
	Greatest Range	18·6 on the 23rd.
	Highest in the Sun ...	146·2 on the 25th.
	Highest in Black Box with Glass Top	206·4 on the 12th.
	Lowest on the Grass ...	56·7 on the 5th.
	Mean Diurnal Range ...	10·0
	Mean in the Shade ...	72·0

(Being 1·3 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	100·0 on the 5th.
	Least	55·0 on the 25th and 26th.
	Mean	78·1

(Being 3·4 greater than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	19 rain. (No dew.)
	Greatest Fall	7·526 inches on the 6th.
	Total Fall	12·948 inches. 65 feet above ground. 16·254 inches. 15 in. above ground.

(Being 9·991 inches greater than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	4·691 inches.
Ozone... ...	Mean Amount	7·0

(Being 2·2 greater than that in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	10
Cloudy Sky...	Mean Amount	7·9
	Number of Clear Days ...	0
Meteors ...	Number Observed... ...	0

Remarks.

Like last month, the mean barometer has been above the average, and the mean temperature 1·3 above the average of 19 years. Very heavy rain, 7·526 inches fell at Sydney on the 6th, and throughout the Colony good rains have fallen, the smallest being 1·01 inch at Boulka, and the greatest 23·39 inches at Bodalla. The Murray River has risen 5 ft. and is still rising. At Wentworth the Darling is below summer level, but a flood is coming down.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

MARCH, 1878.—GENERAL ABSTRACT.

Barometer ...	Highest Reading	30·160 inches on the 22nd at 8.45 a.m.
At 32° Faht.	Lowest Reading	29·418 inches on the 27th at 3 p.m.
	Mean Height	29·886 inches.

(Being 0·010 inch less than that in the same month on an average of the preceding 19 years.)

Wind... ...	Greatest Pressure... ...	14·6 lbs. on the 30th.
	Mean Pressure	0·4 lb.
	Number of Days Calm ...	1
	Prevailing Direction ...	E.N.E.

(Prevailing direction during the same month for the preceding 19 years, N.E.)

Temperature	Highest in the Shade ...	91.3 on the 16th.
	Lowest in the Shade ...	57·6 on the 31st.
	Greatest Range	22·5 on the 30th.
	Highest in the Sun ...	143·0 on the 16th.
	Highest in Black Box with Glass Top	193·1 on the 12th.
	Lowest on the Grass ...	47·8 on the 31st.
	Mean Diurnal Range ...	11·4
	Mean in the Shade ...	72·0

(Being 3·2 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount... ...	100·0 on the 7th, 24th, and 25th.
	Least	47·0 on the 16th.
	Mean	79·9

(Being 3·5 greater than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	8 rain and 3 dew.
	Greatest Fall	0·652 inches on the 23rd.
	Total Fall	1·410 inch. 65 ft. above ground. 1·992 inch. 15 in. above ground.

(Being 3·496 inches less than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	5·057 inches.
Ozone... ...	Mean Amount	6·5

(Being 1·4 greater than hat in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	3
Cloudy Sky...	Mean Amount	6·8
	Number of Clear Days ...	0
Meteors ...	Number Observed ...	0

Remarks.

The temperature this month has been unusually high, and the mean is 3·2 greater than the average of past 19 years. Moderate rains have fallen generally over the Colony, the heaviest being 8·88 inches at Deniliquin, and the least 0·68 inch at Gilgoin. At Wentworth the Rivers Murray and Darling are 11 ft. 9 in. above summer level, but no appearance of a high flood; at Bathurst, mosquitoes and grasshoppers never known to be so numerous as during this month.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

APRIL, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·267 inches on the 9th at 10·50 a.m.
	Lowest Reading	29·392 inches on the 28th at 3 a.m.
	Mean Height	29·921 inches.

(Being 0·005 inch less than that in the same month on an average of the preceding 19 years.)

Wind... ...	Greatest Pressure... ...	32·0 lbs. on the 29th
	Mean Pressure	0·4 lb.
	Number of Days Calm ...	1
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 19 years, W.)

Temperature	Highest in the Shade ...	79·0 on the 19th.
	Lowest in the Shade ...	51·9 on the 25th.
	Greatest Range	20·1 on the 16th.
	Highest in the Sun ...	139·7 on the 19th.
	Highest in Black Box with Glass Top	178·2 on the 1st.
	Lowest on the Grass ...	45·3 on the 25th.
	Mean Diurnal Range ...	13·4
	Mean in the Shade ...	66·1

(Being 1·1 inch greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	100·0 on the 10th.
	Least	47·0 on the 15th.
	Mean	75·9

(Being 1·6 less than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	8 rain and 6 dew.
	Greatest Fall	0·896 inch on the 11th.
	Total Fall	1·522 inch. 65 feet above ground. 1·769 inch. 15 in. above ground.

(Being 5·433 inches less than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	3·570 inches.
Ozone	Mean Amount	6·5

(Being 1·3 greater than that in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	4
Cloudy Sky...	Mean Amount	4·5
	Number of Clear Days ...	4
Meteors ...	Number Observed... ...	2

Remarks.

The barometer this month has been slightly below the average of past 19 years, and the temperature 1·1 above the average. Rain in the Colony generally has been light, but along the coast an average quantity has fallen. At Wentworth the Murray and Darling Rivers are 8 ft. 6 in. above summer level, and falling. Navigation on the Darling is almost closed; during the late flood some of the steamers got up the river as far as Wilcannia.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE, 33° 51′ 41″; LONGITUDE, 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

MAY, 1878.—GENERAL ABSTRACT.

Barometer .. At 32° Faht.	Highest Reading	30·357 inches on the 6th at 11 a.m.
	Lowest Reading	29·712 inches on the 24th, at 3 p.m.
	Mean Height	29·967 inches.

(Being 0·046 inch greater than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure	8·8 lbs. on the 11th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 19 years, W.)

Temperature	Highest in the Shade ...	73·4 on the 12th.
	Lowest in the Shade ...	44·9 on the 11th.
	Greatest Range	22·0 on the 1st.
	Highest in the Sun ...	128·3 on the 2nd.
	Highest in Black Box with Glass Top	152·4 on the 2nd.
	Lowest on the Grass ...	39·1 on the 15th.
	Mean Diurnal Range ...	14·9
	Mean in the Shade ...	57·7

(Being 0·8 less than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	100·0 on the 26th.
	Least	51·0 on the 1st.
	Mean	78·6.

(Being 2·5 greater than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	6 rain and 16 dew.
	Greatest Fall	0·562 inch. On the 27th.
	Total Fall	0·549 inch. 65 feet above ground.
		0·817 inch. 15 in. above ground.

(Being 4·552 inches less than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	2·355 inches.
Ozone	Mean Amount	6·5

(Being 1·6 inch greater than that in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	4·2
	Number of Clear Days ...	1
Meteors ...	Number Observed ...	4

Remarks.

This is the first month this year in which the mean temperature has been below the average of 19 years, and now it is only 0·8 less. The rainfall has been very light throughout the Colony, except the Clarence River District, where moderate rains have fallen. At Wentworth the Darling is down to summer level, and the Murray is 10 feet above summer level.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

JUNE, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·156 inches on the 22nd at 9 a.m.
	Lowest Reading	29·367 inches on the 13th at 1 p.m.
	Mean Height	29·802 inches.

(Being 0·180 inch less than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure	14·0 lbs. on the 12′, 13′ and 14′.
	Mean Pressure	1·4 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 19 years, W.)

Temperature	Highest in the Shade ...	63·1 on the 12th.
	Lowest in the Shade ...	38·7 on the 17th.
	Greatest Range	17·8 on the 18th.
	Highest in the Sun ...	123·0 on the 14th.
	Highest in Black Box with Glass Top	137·3 on the 23rd.
	Lowest on the Grass ...	32·8 on the 20th.
	Mean Diurnal Range ...	12·8
	Mean in the Shade... ...	51·3

(Being 3·5 less than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	99·0 on the 23rd and 26th.
	Least	50·0 on the 20th.
	Mean	71·9

(Being 5·2 less than that of the same month on an average of the preceding 18 years.)

Rain	Number of Days	10 rain and 4 dew.
	Greatest Fall	2·995 inches. On the 3rd.
	Total Fall	5·190 inches. 65 feet above ground. 7·167 inches. 15 in. above ground.

(Being 1·549 inches greater than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	2·239 inches.
Ozone... ...	Mean Amount	8·3

(Being 3·1 greater than that in the same month on an average of the preceding 19 years.)

Electricity	Number of Days Lightning	6
Cloudy Sky ...	Mean Amount	3·9
	Number of Clear Days ..	3
Meteors ...	Number Observed... ...	3

Remarks.

This month the mean temperature is 3·5 below the average of 19 years. Generally there has been a moderate rainfall, except in the far west where little or none has fallen. On the 8th, at 3 p.m., a remarkable meteor was seen here and the border of Queensland, and at Geelong, in Victoria. It was vertical over Cooma, 257 miles S.W. by S. from Sydney. At Wentworth the Darling is at summer level, and the Murray 8 feet above summer level and rising.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

JULY, 1878.—GENERAL ABSTRACT.

Barometer .. At 32° Faht.	Highest Reading	30·221 inches on the 30th at 9 a.m.
	Lowest Reading	29·343 inches on the 19th at 1·25 p.m.
	Mean Height	29·826 inches.

(Being 0·119 inch less than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure	19·2 lbs. on the 27th.
	Mean Pressure	0·7 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 19 years, W.)

Temperature	Highest in the Shade ...	71·2 on the 26th.
	Lowest in the Shade ...	39·7 on the 8th.
	Greatest Range	21·2 on the 10th.
	Highest in the Sun ...	121·1 on the 20th.
	Highest in Black Box with Glass Top	160·7 on the 29th.
	Lowest on the Grass ...	34·0 on the 9th.
	Mean Diurnal Range ...	14·2
	Mean in the Shade ...	52·7

(Being 0·2 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	100·0 on the 12th and 13th.
	Least	53·0 on the 1st, 2nd, and 20th.
	Mean	76·0

(Being 1·2 greater than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	10 rain and 13 dew.
	Greatest Fall	1·669 inches on the 12th.
	Total Fall	1·846 inch. 65 ft. above ground. 3·495 inches. 15 in. above ground.

(Being 1·164 inch less than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	2·111 inches.
Ozone	Mean Amount	7·1

(Being 2·2 greater than that in the same month on an average of the preceding years.)

Electricity ...	Number of Days Lightning	5
Cloudy Sky ...	Mean Amount	5·1
	Number of Clear Days ...	4
Meteors ...	Number Observed ...	4

Remarks.

The mean barometer is 0·119 inch less than the average of past 19 years, and temperature is only 0·2 greater. Except the Darling District, fine rains have fallen generally, the heaviest being 5·45 inches at Orange. At Wentworth the Darling is still at summer level, and the Murray is 14 feet above summer level.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

AUGUST, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·282 inches on the 21st at 9 a.m.
	Lowest Reading	29·406 inches on the 11th at 4 a.m.
	Mean Height	29·857 inches.

(Being 0·090 inch less than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure... ...	13·0 lbs. on the 9th.
	Mean Pressure	0·5 lb.
	Number of Days Calm ...	3
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 19 years, W.)

Temperature	Highest in the Shade ...	77·9 on the 28th.
	Lowest in the Shade ...	40·6 on the 7th.
	Greatest Range	29·6 on the 28th.
	Highest in the Sun ...	149·0 on the 30th.
	Highest in Black Box with Glass Top	160·7 on the 28th.
	Lowest on the Glass ...	35·6 on the 7th.
	Mean Diurnal Range ...	16·4
	Mean in the Shade ...	56·4

(Being 1·8 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	100·0 on the 2nd.
	Least	37·0 on the 13th and 23rd.
	Mean	68·8

(Being 3·1 less than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	5
	Greatest Fall	2·280 inches. On the 2nd.
	Total Fall	1·936 inches. 65 ft. above ground.
		3·304 inches. 15 in. above ground.

(Being 0·540 inch greater than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	3·814 inches.
Ozone	Mean Amount	8·3

(Being 3·2 greater than that in the same month on an average of the preceding 17 years.)

Electricity ..	Number of Days Lightning	5
Cloudy Sky...	Mean Amount	2·9
	Number of Clear Days ...	6
Meteors ...	Number Observed... ...	2

Remarks.

The barometer is 0·090 less, and the temperature 1·8 greater than the average of the past 19 years. A remarkably heavy shower of rain, in which 1·16 inches fell in 12 minutes; a mile east of the Observatory there was none, and from that position the rain could be seen like a wall of water passing from north to south over the Observatory. On the same day a similar shower passed over Wollongong, during which 6 inches of rain fell.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

SEPTEMBER, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·173 inches on the 8th at 9 a.m.
	Lowest Reading	29·217 inches on the 24th at 7 p.m.
	Mean Height	29·772

(Being 0·116 inch less than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure... ...	17·4 lbs. on the 24th and 28th.
	Mean Pressure	0·8 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	W.

(Prevailing direction during the same month for the preceding 19 years, W.)

Temperature	Highest in the Shade ...	87·5 on the 21st.
	Lowest in the Shade ...	44·2 on the 30th.
	Greatest Range	29·3 on the 21st.
	Highest in the Sun ...	142·2 on the 12th.
	Highest in Black Box with Glass Top	184·5 on the 21st.
	Lowest on the Grass ...	39·2 on the 29th.
	Mean Diurnal Range ...	14·7
	Mean in the Shade ...	60·2

(Being 1·7 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount... ...	100·0 on the 3rd, 5th, and 27th.
	Least	29·0 on the 21st.
	Mean	74·0

(Being 4·6 greater than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	18 rain and 6 dew.
	Greatest Fall	3·060 inches. On the 6th.
	Total Fall	4·472 inches. 65 feet above ground.
		5·852 inches. 15 in. above ground.

(Being 3·346 inches greater than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	3·711 inches.
Ozone... ...	Mean Amount	7·6

(Being 2·2 greater than that in the same month on an average of the preceding 17 years.)

Electricity ...	Number of Days Lightning	3
Cloudy Sky ...	Mean Amount	5·7
	Number of Clear Days ...	4
Meteors ...	Number Observed ...	2

Remarks.

The mean barometer is 0·116 less, and the temperature 1·7 greater than the average of the past 19 years; valuable rains have fallen, and this time have reached the Darling; at Bourke, 3·85 inches fell; at Walgett, 4·39 inches; but in the lower parts of the Darling River little or no rain has fallen; on the coast the rain has been heavy—greatest, 5·85 inches at Sydney.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 33′ 45″ East.

OCTOBER, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·146 inches on the 5th at 10 a.m.
	Lowest Reading	28·967 inches on the 10th at 3 p.m.
	Mean Height	29·788 inches.

(Being 0·050 inch less than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure	27·4 lbs. on the 11th and 15th.
	Mean Pressure	1·1 lb.
	Number of Days Calm ...	0·
	Prevailing Direction ...	N.E.

(Prevailing direction during the same month for the preceding 19 years, N.E.)

Temperature	Highest in the Shade ...	86·5 on the 30th.
	Lowest in the Shade ...	49·7 on the 17th.
	Greatest Range	30·3 on the 4th.
	Highest in the Sun ...	139·0 on the 14th and 29th.
	Highest in Black Box with Glass Top	198·3 on the 29th.
	Lowest on the Grass ...	37·7 on the 17th.
	Mean Diurnal Range ...	15·4
	Mean in the Shade ...	63·6

(Being 0·1 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount	100·0 on the 28th.
	Least	29·0 on the 14th.
	Mean	68·6

(Being 0·1 less than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	10 rain and 3 dew.
	Greatest Fall	0·520 inches on the 29th.
	Total Fall	1·859 inch. 65 feet above ground. 1·999 inch. 15 in. above ground.

(Being 0·848 inch less than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	4·872 inches.
Ozone	Mean Amount	7·4

(Being 2·0 greater than that in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	8
Cloudy Sky ...	Mean Amount	5·7
	Number of Clear Days ...	1
Meteors ...	Number Observed ...	1

Remarks.

This month barometer and thermometer are very close to the average for 19 years. Coast rains have been light, and the mountains and western slopes have had fine rains; but at Wentworth the fall has been light.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 40s; MAGNETIC VARIATION 9° 25′ 2″ East.

NOVEMBER, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	30·167 inches on the 7th at 10·20 a.m.
	Lowest Reading	29·279 inches on the 21st at 2 p.m.
	Mean Height	29·761 inches.

(Being 0·041 inch less than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure... ...	18·6 lbs. on the 21st.
	Mean Pressure	0·8 lb.
	Number of Days Calm ...	0
	Prevailing Direction ...	S.

(Prevailing direction during the same month for the preceding 19 years, S.

Temperature	Highest in the Shade ...	102·7 on the 21st.
	Lowest in the Shade ...	53·6 on the 1st.
	Greatest Range	37·5 on the 21st.
	Highest in the Sun ...	154·2 on the 21st.
	Highest in Black Box with Glass Top	210·3 on the 21st.
	Lowest on the Grass ...	44·5 on the 8th.
	Mean Diurnal Range ...	16·4
	Mean in the Shade ...	68·6

(Being 2·1 greater than that of the same month on an average of the preceding 19 years.

Humidity ...	Greatest Amount	100·0 on the 1st and 6th.
	Least	15·8 on the 21st.
	Mean	67·8

(Being 1·6 less than that of the same month on an average of the preceding 19 years.

Rain	Number of Days	7 rain and 1 dew.
	Greatest Fall	0·750 inches on the 1st.
	Total Fall	0·765 inch. 65 feet above ground.
		1·931 inch. 15 in. above ground.

(Being 1·504 inch less than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	6·577 inches.
Ozone	Mean Amount	6·9

(Being 1·8 greater than that in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	0
Cloudy Sky...	Mean Amount	5·4
	Number of Clear Days ...	0
Meteors ...	Number Observed ...	2

Remarks.

The temperature this month is again above the average by 2·1, and on the 21st the maximum in shade reached the unusually high temperature 102·7. Moderate rains have fallen, except in the far west and part of the New England District. The Murray and Darling Rivers in full flood at Wentworth, the rainfall at Bourke was only 1·68 inch, but on the upper tributaries to the Darling was heavy, and at Narrabri reached 4·65 inches.

GOVERNMENT OBSERVATORY, SYDNEY.

LATITUDE 33° 51′ 41″; LONGITUDE 10h 4m 46s; MAGNETIC VARIATION 9° 25′ 2″ East.

DECEMBER, 1878.—GENERAL ABSTRACT.

Barometer ... At 32° Faht.	Highest Reading	29·993 inches on the 19th at 11.30 a.m.
	Lowest Reading	29·171 inches on the 25th at 4 p.m.
	Mean Height	29·673 inches.

(Being 0·078 inch less than that in the same month on an average of the preceding 19 years.)

Wind	Greatest Pressure... ...	14·6 lbs. on the 20th.
	Mean Pressure	0·8
	Number of Days Calm ...	0
	Prevailing Direction ...	S.

(Prevailing direction during the same month for the preceding 19 years, E.N.E.)

Temperature	Highest in the Shade ...	89·1 on the 17th.
	Lowest in the Shade ...	56·3 on the 2nd.
	Greatest Range	26·3 on the 3rd.
	Highest in the Sun ...	152·4 on the 23rd.
	Highest in Black Box with Glass Top	223·5 on the 23rd.
	Lowest on the Grass ...	50·5 on the 26th.
	Mean Diurnal Range ...	13·2
	Mean in the Shade ...	70·4

(Being 0·8 greater than that of the same month on an average of the preceding 19 years.)

Humidity ...	Greatest Amount... ...	99·0 on the 15th at 9 a.m.
	Least	28·0 on the 17th at 3 p.m.
	Mean	72·9

(Being 8·1 greater than that of the same month on an average of the preceding 19 years.)

Rain	Number of Days	16 rain 1 dew.
	Greatest Fall	1·131 inches on the 15th.
	Total Fall	2·979 inches. 65 feet above ground. 4·094 inches. 15 in. above ground.

(Being 1·874 inches greater than that of the same month on an average of the preceding 19 years.)

Evaporation	Total Amount	6·300 inches.
Ozone... ...	Mean Amount	7·7

(Being 3·3 greater than that in the same month on an average of the preceding 18 years.)

Electricity ...	Number of Days Lightning	8
Cloudy Sky ...	Mean Amount	7·0
	Number of Clear Days ...	2
Meteors ...	Number Observed ...	0

Remarks.

Barometer 0·078 below and temperature 0·8 greater than the average of 19 years, and the maximum in shade is only 89·1, as compared with 102·7 last month. Generally the rain has been from 1 to 4 inches, and at Kurrajong reached 11 inches. At Wentworth the Murray and Darling are 19 feet above summer level, but falling here and up the rivers.

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